ANNALS

OF THE

SOUTH AFRICAN MUSEUM

VOLUME XII

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DESCRIPTIONS OF THE PALAEONTOLOGICAL MATERIAL COLLECTED BY THE SOUTH AFRICAN MUSEUM AND THE GEOLOGICAL SURVEY OF SOUTH AFRICA

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ERRATA.

(Part 8.)

Page 348, line 33, *for* " from " *read* " form."
,, 355, ,, 6, ,, " Ornitosuchus " *read* " Ornithosuchus."
,, 355, ,, 21, ,, " Spenosuchus " ,, " Sphenosuchus."
,, 357, ,, 34, ,, " doracoid " ,, " coracoid."
,, 357, ,, 38, ,, " Spenosuchus " ,, " Sphenosuchus."
,, 358, ,, 10, ,, " Broem " ,, " Broom."
,, 395, ,, 27, ,, " public " ,, " pubic."
,, 398, ,, 19, ,, " to " ,, " no."
,, 409, ,, 5, ,, " width " ,, " with."
,, 416, in description of fig. 36, *for* " pelvis " *read* " pubis."
,, 417, line 12, *delete* " A figure is given herewith."
,, 439, line 17, *for* " builders " *read* " boulders."
,, 439, ,, 24, ,, second " of " *read* " or."
,, 444, last line, *for* " place " *read* " plane."
,, 457, last word, *for* " microline " *read* " microcline."
,, 464, line 5, *for* " it," *read* " if."
,, 464, ,, 25, ,, " tick " *read* " thick."
,, 468, ,, 24, ,, " pruvial " *read* " pluvial."
,, 475, ,, 13, ,, " transportion " *read* " transportation."
,, 546, ,, 38, ,, " are " ,, " is."

There are a number of typographical errors scattered through the two papers, which have largely entered in since the reading of the final proof-sheets; but these will be obvious to anyone acquainted with the English tongue, and have not therefore been listed above.

The title to Dr. Haughton's paper on p. 499 is incorrect and should be replaced by the following :—

18.—*Investigations in South African Fossil Reptiles and Amphibia* (Part 12).—By S. H. HAUGHTON, B.A., D.Sc., F.G.S., Honorary Curator of the Palaeontological Collections.

12. *On Some Gorgonopsian Skulls in the Collection of the South African Museum.* (With 8 Text-figures.)

LIST OF PLATES.

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ANNALS

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SOUTH AFRICAN MUSEUM.

(Vol. XII.)

1.—*On some Fishes from the Lower and Middle Karroo Beds.*—By R. Broom, M.D., D.Sc.

With the exception of a couple of species of *Atherstonia*, described by Smith Woodward, almost nothing has been known of the fishes of the Lower and Middle Karroo. The fishes of the Burghersdorp beds and of the Cave sandstone have been dealt with by Smith Woodward and by myself, and a good many forms are now known. The fishes of the older rocks, though less varied than those of the upper, are nevertheless interesting. The types of the following specimens are in the collection of the South African Museum.

PALÆONISCIDAE.

Palæoniscus capensis, sp. nov.

This new species is founded on three specimens from the Hantam Mountains, 12 miles west of Calvinia, and from beds which are probably Upper Dwyka, and thus of Lower Permian age. The specimens unfortunately are all of the posterior part of the fishes—one shows almost all except the head, but the other two only the tail halves. The preservation of the specimens is marvellously perfect.

The total length of the specimen was probably 300 mm., and the greatest depth of the body about 75 mm.

The dorsal fin is placed more anteriorly than in *Palæoniscus macropomus*, and the distance between the pectoral and pelvic fins is also less. The front of the dorsal fin is opposite the point midway between the front of the pectoral and pelvic fins. The dorsal fin has 38 rays, of which the 9th is the longest. Distinct fulcra are present. All the rays are jointed. The anterior short rays and the first three of the long ones are undivided, but the later rays are all bifurcated at their tips.

The structure of the pectoral and pelvic fins cannot be very clearly made out. The rays are jointed and apparently bifurcated.

The anal fin is of moderate size. It consists of 52 rays, all jointed, and the posterior ones bifurcated distally. There are well-developed fulcra.

The caudal fin is large and deeply bifurcated. The lower lobe is smaller than the upper.

The scales on the anterior part of the body are ornamented by a series of obtuse ridges. On the upper part of the scale the ridges run backwards a short distance, then curve downwards and run parallel to the posterior border of the scale. From the anterior border of the scale other ridges run backwards, stopping at the point where the descending ridges would meet them. On the posterior scales there are only a few transverse blunt ridges on the anterior part of the scale. The scales on the ventral surface between the pectoral and pelvic fins are considerably enlarged. Between the pelvic and anal fins are a number of enlarged scales. Two moderately large scales are placed on either side just in front of the anal fin, and in front of these two is a much larger median scale. Enlarged median scales are also placed over the upper lobe of the tail—largest at its base.

Elonichthys whaitsi, sp. nov.

This very fine fish was discovered by the Rev. J. H. Whaits on the farm Droogvoets, Fraserburg District. The specimen is nearly complete, only a portion of the upper border being lost. The head is crushed and not well preserved.

The total length of the type is 280 mm., and the greatest depth of the body is probably 80 mm.

The fins are large and powerful. The dorsal is situated about the middle of the body, and the anal begins a little in front of the posterior part of the dorsal.

The most of the front of the dorsal fin is missing, but there are

30 rays behind the 1st long ray. There are well-developed fulcra. All the rays are jointed, and all except perhaps the first two long ones are branched.

The pelvic fin has 27 rays, all jointed, and the posterior rays branched.

The anal fin is very large. It has 48 rays, of which the first nine are short. All the rays are jointed, and the short anterior rays and the first six of the long rays are unbranched. All the posterior rays are bifurcated.

The caudal fin is very powerful and deeply bifurcated. The lower lobe is quite as large as the upper. All the rays are branched, but most only bifurcated.

The scales of the anterior part of the body are rhombic, with feeble transverse irregular ridges and denticulate posterior margins. The posterior scales are unornamented.

Some very large scales are situated in front of the anal fin, and large ridge scales are also above the root of the tail.

Atherstonia cairncrossi, sp. nov.

This new species of *Atherstonia* is founded on the greater part of a fish found by Mr. J. L. Cairncross at Coleskop in 1906, and presented by him to the South African Museum. It was regarded at the time as a small specimen of *Atherstonia scutata*, S.-W., but on comparing it with undoubted specimens of the type species in the Albany Museum it is seen to be a different species.

It differs from *A. scutata* in being relatively shorter and deeper. In *A. scutata* the length from the clavicle to the base of the tail is about 200 mm., and the greatest depth of the body about 75 mm.; in this new species the length from the clavicle to the base of the tail is 117 mm., and the greatest depth 57 mm. In other words, the depth of the body in the new species is half the length without the head and tail; in *A. scutata* the depth is only a little more than $\frac{1}{3}$ the length.

The dorsal fin has a long base and is powerful. It begins nearer to the clavicle than to the base of the tail, and not as in *A. scutata* nearer to the tail. The enlarged ridge scales do not strengthen the front of the fin so markedly as in *A. scutata*, and the fulcra are very rudimentary. There are about 43 rays, which are jointed but not bifurcated.

The pelvic fin is in front of the dorsal, ending opposite the point where the dorsal begins. It has about 25 jointed rays.

The anal fin is about the same size as the dorsal, and begins opposite the point of union of the latter and middle thirds of the dorsal. It has about 36 jointed but unbranched rays. The fulcra are rudimentary.

The caudal fin is very imperfectly preserved.

There is, as in *A. scutata*, a row of ridge scales both in front of and behind the dorsal fin. Those between the dorsal and tail are very large and only feebly ornamented. Those in front of the dorsal are smaller, thinner, and more distinctly striated. The body scales are obliquely striated and posteriorily feebly but distinctly denticulated.

Family PLATYSOMATIDAE.

Caruichthys ornatus, g. et sp. n.

The type of this species is a single specimen found at Doorn River, in the Cradock district, and most probably from beds of the *Lystrosaurus* zone.

A small portion of the front of the head is missing, and the whole of the tail from behind the dorsal fin.

The trunk is deeper than in *Eurynotus*, but not so deep as in *Platysomus*. The head is large and deep, somewhat resembling the head of *Platysomus*, but with relatively much more powerful jaws and with the branchiostegal rays large and extending much below the mandibles. The teeth are small and styliform. The dorsal margin curves up and back above the head and then passes nearly directly backwards to the dorsal fin. Along this dorsal margin are a series of enlarged much ornamented scales. At the commencement of the dorsal fin the line of the body margin abruptly passes downwards and backwards as in *Platysomus*.

The pectoral fin is large and possibly not unlike that in *Eurynotus*. It is too imperfectly preserved to show its structure. Only the anterior part of the dorsal fin is preserved. There are a series of 9 or 10 short but gradually lengthening rays in front of what is probably the longest ray of the fin. These short rays are jointed but unbranched. In front of the first long ray are feeble fulcra. The later rays of the fin are long and much feebler than the anterior. They are jointed and unbranched. The pelvic fin is much larger than that in *Eurynotus*. It has about 40 rays—all jointed and unbranched. The posterior part of the fin is distinctly

in front of the beginning of the dorsal. No parts of the anal or caudal fins are preserved.

The scales are very narrow and deep and much imbricated. Each is ornamented by numerous irregular prominent transverse ridges. The rows of scales below the dorsal fin are smaller, and the scales immediately above the pelvic fin are small.

The length from the snout to the front of the dorsal is 140 mm. The whole length of the fish is probably about 210 mm. The greatest depth of the body is 100 mm.

2.—*On a New South African Stegocephalian* (Phrynosuchus whaitsi). —By R. Broom, M.D., D.Sc.

The little Stegocephalian about to be described was found by the Rev. J. H. Whaits on the farm Droogvoets, in the Fraserburg district. The exact horizon of the locality is not certain, as the other fossil remains are either dissimilar from those known in the South or are too fragmentary to be of service. Most probably the zone corresponds to the upper part of Endothiodont zone of the southern Karroo.

The specimen consists of much of the skull in a very weathered condition, remains of most of the vertebrae and short ribs as far as the pelvic region, the most of the right front and hind limbs, and considerable indications of the dermal covering. Allowing for a moderate tail, the whole animal probably measured about 350 mm.

The skull shows the impressions of most of the bones of the cranium, and is so broken across as to reveal the structure of at least the front half of the palate. The whole head is broad and very flat. The nostrils are wide apart, and the orbits, which are also far apart, are entirely in the anterior half of the skull.

The nasal is probably very large, the prefrontal and lachrymal very small. Each frontal is broad, and shut out from the orbital margin by the meeting of the postfrontal with the prefrontal.

The postfrontal is large and forms the greater part of the upper orbital margin. The postorbital is much smaller.

The parietal is a large bone, with a small pineal foramen between the pair of bones. The squamosal is rather smaller than the parietal. Outside of the squamosal is a large quadrato-jugal.

Behind the parietal is a large dermo-occipital.

The parasphenoid (or vomer) is of large size and extends far forward as a broad, flat plate. The prevomers are large and the internal nares far apart. The palatines are also large.

The teeth are not well shown but are manifestly labyrinthodont.

The length of the skull is about 68 mm., and the width almost exactly the same.

Behind the occiput are some crushed bones which may be parts of the clavicles and interclavicles, and by the sides of the neck are some small ossicles which may be the remains of gill arches.

The body is long and salamander-like. The vertebrae are very imperfectly ossified and represented by paired ossifications, probably representing pleurocentra. The ribs are short as in the Branchiosauridae and almost straight.

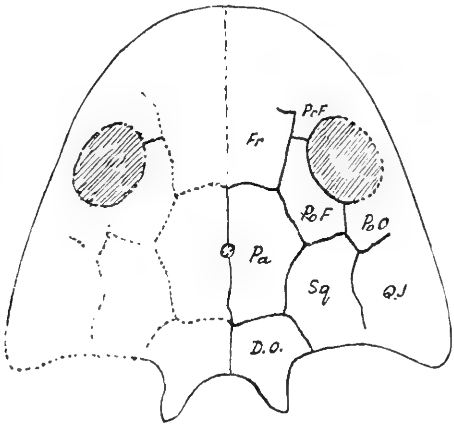


FIG. 1.—Skull of *Phrynosuchus whaitsi*. Very slightly reduced.

The shoulder girdle and clavicular apparatus are not well preserved, but the humerus, radius, and ulna of the right side are seen. The humerus is a short bone with a moderately wide distal end. The length is 16 mm. and the distal end is 9 mm. wide. The radius is a slender rod 10 mm. in length and the ulna is rather stouter.

Of the hind limb the only parts preserved are a portion of the tibia, five metatarsals, and two phalanges. There are certainly five digits, and the tarsus is unossified.

There is a complete exoskeleton of thin, ossified scales.

The type, which has been named after the Rev. J. H. Whaits, has been placed in the South African Museum.

3.—*On a Nearly Perfect Skull of a New Species of the Gorgonopsia.* —By R. Broom, M.D., D.Sc.

The skull here described was found by Mr. S. H. Haughton on the farm Dunedin, Beaufort West, about 3 miles WSW. of the homestead. The exact horizon of the beds is still uncertain, but they must be at least 2,000 feet above the horizon of Beaufort West. Whether they correspond to the *Cistecephalus* beds or may be as high as the *Lystrosaurus* zone is at present in doubt. We know that *Cistecephalus* occurs at Kuilspoort probably 1,500 feet above the horizon of Beaufort West, and about 500 feet higher up there are obscure indications which incline me to believe we are into the *Lystrosaurus* zone, but as Dr. Rogers, who has gone over the ground, is rather opposed to this idea, we must at present leave the matter in doubt. In any case it is quite certain that the specimen comes from a very much higher zone than does *Gorgonops torvus*, Owen. Owen's type comes from Fort Beaufort, and it has also been obtained at Beaufort West, so that there is no doubt it belongs to the lower part of the *Endothiodon* zone, not more than a few hundred feet above the *Pareiasaurus* zone. Another Gorgonopsid occurs in the same zone, viz. *Scymnognathus whaitsi* recently described by me. The occurrence of a new Gorgonopsid at a very much higher horizon is thus particularly interesting, and the fact that the skull is the most perfect known and reveals most of the details of the structure makes the find a most important one.

The skull measures 190 mm. in length, and the greatest width across the temporal region is about 128 mm. The snout is rounded and broader than deep. The nostrils are directed forwards and are much flattened as in *Gorgonops torvus*. The frontal region is broad and the orbits look more outwards than upwards. The parietal region is as broad as the frontal and the temporal fossae of fair size. The occiput is nearly vertical, sloping only very slightly backwards from the parietal.

The premaxillary is similar to the Therocephalian type. It bears 5 rounded and pointed incisors. I do not find any evidence of

serration, though the evidence is not quite conclusive. The 5 incisors measure 23 mm.

The septomaxilla is also as in Therocephalians. The posterior process is long and separates the anterior part of the nasal from the maxilla.

The maxilla is large and deep. In front it overlaps the premaxilla. There is a single fair-sized canine situated 8 mm. behind the last incisor, and measuring in section 8·5 mm. by 6 mm. There are a few small rounded molars, but the exact number cannot be made out with certainty. Three are preserved. Possibly the original number was 5. These molars are only about $\frac{1}{3}$ of the size of the incisors.

The nasal is large and fairly wide. It is only slightly wider at the front and behind than it is in the middle. The internasal process is evidently feeble.

The prefrontal is large and forms the upper and anterior quarter of the orbital margin. It unites behind with the postfrontal, shutting out the frontal from the orbit. In this it agrees with the conditions in the higher Cynodonts and differs from all known Therocephalians, and also from the lower Cynodonts and from the Anomodonts.

The lachrymal is of moderate size, and the canal seems to be inside the orbit.

The jugal is fairly large but much hidden by the overlapping squamosal and postorbital.

The frontal is large, the two forming most of the interorbital region. On its outer side it articulates with the prefrontal and postfrontal. Behind it meets the parietal and preparietal.

In the middle line between the two frontals and the two parietals is a small median bone, manifestly the bone which in the Anomodonts has been called the preparietal. This character is perhaps the most interesting in the skull. For long the little median bone which lies mainly in front of the parietal foramen has been known in the Anomodonts. It has been variously named parietal, interparietal and preparietal. Quite certainly it is neither the parietal nor the interparietal, and the name preparietal proposed by Seeley and adopted by myself and others seems the best name for it. It is known in all Anomodonts except *Cistecephalus*, but hitherto it has not been recognised in any other group. The discovery of a preparietal in another group is thus of great interest. It pretty certainly does not occur in most Therocephalians. That it should occur in the Gorgonopsidae, the group which in some other respects most approaches the Anomodonts adds further confirmation to the view I expressed many years ago that the Anomodonts are descended

from a Therocephalian ancestor. In some Anomodonts the foramen is in the middle of the bone; in others the bone lies in front of the foramen though forming its anterior wall. In no known Anomodont is the foramen as here between the parietals and the preparietal away from the foramen.

The postfrontal is unusually large. In Anomodonts it is always small, and in Therocephalians it was also small where it could be made out distinctly. Here it forms much of the orbital margin and quite a large part of the upper cranial wall. For the most part it lies between the frontal and the postorbital. Posteriorly it meets the parietal.

The parietal is about as large as the frontal. In front it meets the preparietal, the frontal, the postfrontal; while laterally it is supported by the postorbital, which completely shuts it out from the temporal fossa. Posteriorly it meets the large median interparietal, and posterior-laterally the squamosal.

The postorbital is large. It forms most of the postorbital arch, and its posterior extension forms the whole of the upper margin of the temporal fossa.

The squamosal is very large and forms practically the whole of the back of the temporal fossa. Its inner side articulates with the interparietal and the exoccipital, and forms about $\frac{1}{3}$ of the occiput. The ends of the parietal and the postorbital are clasped by the upper and inner part of the bone. Immediately outside the lateral occipital foramen the squamosal has a vertical posterior ridge which apparently delimits the occiput proper from the groove which is probably the auditory groove. The lower and outer part of the squamosal passes down and almost entirely conceals the quadrate. The outer part of the bone curves outwards and then forwards, forming most of the zygomatic arch. Much of the inner side of the arch is, however, formed by the jugal.

The interparietal is a large median bone a little broader than deep It is bounded above by the parietals, laterally by the squamosals and inferiorly by the exoccipitals.

The exoccipitals appear to form the whole of the occipital region above and to the sides of the foramen magnum. There is a well-developed lateral process which apparently meets the quadrate.

The quadrate lies almost entirely in front of the descending part of the squamosal, and is thus scarcely seen when viewed from behind. Towards the quadrate there runs out a long process of the pterygoid, but whether it reaches the quadrate is not quite clear. The quadrate certainly has a short process which runs forward and

inwards towards the pterygoid, but between the two there seems to be another element. If this is so it will probably prove to be the alisphenoid. As the specimen is slightly crushed one cannot be quite positive on this point.

There is an elongated stapes not unlike that of *Cynognathus*, which stretches from the quadrate to the foramen ovale, which lies as in the Anomodonts in the process formed by the basioccipital, basisphenoid, and doubtless the pro-otic and opisthotic.

The basioccipital is a small bone which appears to form most of the single occipital condyle. The foramen for the IXth, Xth, XIth, and XIIth nerves is as in the Anomodonts far back by the side of the condyle.

The basisphenoid meets the basioccipital very much as in the Anomodonts, but in front the bone differs in having a strong deep median keel as in *Bauria*.

The pterygoid is rather peculiar. It has a large posterior process towards the quadrate and also a broad support along the basisphenoid. It has, as in most Therapsida, a powerful lateral process by the side of the mandible, but the anterior development is smaller than in any other of the Therapsida except the Anomodonts. I fail to find any teeth on the pterygoid.

The transpalatine is well developed but also of an unusual character and quite unlike that of the Therocephalia. It forms quite a large part of the bony palate and the anterior part of the lateral descending process.

The palatine is a large bone which takes the place usually occupied by the anterior part of the pterygoid. It also forms most of the bony palate. On the inner part are a few fairly large teeth.

The vomer is not displayed, but probably is as in *Gorgonops* and *Scymnognathus* a true median vomer.

The greater part of each mandible is preserved. The dentary is powerful but the coronoid process probably short. The splenial is also well developed but does not extend far back. The angular is apparently pretty similar to that of *Scymnognathus*. It passes well forwards between the dentary and splenial. The exact nature of the articular region cannot be made out with certainty. Besides an articular it seems there may be a prearticular.

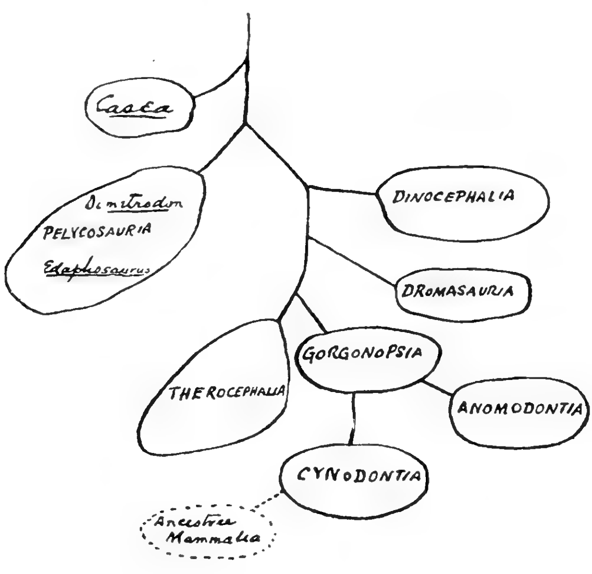
The skull is particularly interesting as showing that the Gorgonopsidae differ in many important characters from the Therocephalian type seen in *Scylacosaurus*, and also by showing some striking resemblances to the skulls of Anomodonts and Cynodonts. In the structure of both the upper cranial region and the palate there is a fore-

shadowing of the peculiar Anomodont type. In the arrangement of the frontals, postfrontals, postorbitals, preparietal, and parietals we have almost the Anomodont condition. The palate of course differs markedly. Still the pterygoid with its very short anterior part meeting the palatine instead of the prevomer and the peculiar condition of the transpalatine are just what we should expect in the Anomodont ancestor. The relations of the stapes, basioccipital, and basisphenoid are almost exactly as in the Anomodonts.

Though the relationships to the Cynodonts are not quite so evident, still this type comes nearer to the Cynodont than does *Scylacosaurus*. If the palatine bones curved over and made a secondary palate and the maxillae also joined over, the whole palate would be not unlike that of the Cynodont. The occiput would resemble that of the Cynodont if the opisthotic were shown on the posterior surface, but this is not a very important character when we consider how variable it is in mammals.

It seems necessary to revive Seeley's Gorgonopsia as a distinct sub-order of the Therapsida for reptiles of the *Gorgonops* type.

The relationships of the various sub-orders of the Therapsida may be expressed as follows:—



For the new skull I suggest the name *Scylacops capensis*, g. et sp. nov.

4.—*Man contemporaneous with Extinct Animals in South Africa.*— By R. Broom, M.D., D.Sc.

For a good many years there has been some evidence that man was contemporaneous with extinct animals in South Africa. Human implements have been found among the gravels at the Vaal River diamond diggings, and from the gravels have also been found teeth of *Equus capensis* and a species of *Mastodon*. But it has been quite impossible to say that man was contemporaneous from the uncertainty of the gravel deposits being of the same age.

At Bloembosch, near Darling, Cape Province, the sand-hills on shifting have revealed remains of *Bubalus baini* and *Equus capensis* in association with human implements. But though the evidence of contemporaneity was quite sufficient for me, it was not as convincing as could be desired.

At Haagenstad saltpan, about 30 miles north of Bloemfontein, a discovery has just been made which removes all possibility of doubt of a human race having inhabited South Africa at a time when there lived many large mammals now quite extinct.

Near the saltpan there is a hot spring which has issued from a large sand-hill. Baths have been erected to utilise the hot water, and recently excavations have been made into the hill to get nearer to the source of the spring. In cutting into the hill a thick deposit of beautiful peat was met with. The peat has evidently been formed by the roots of bushes and trees, and as the deposit is 8 or 10 feet in thickness, it must represent the growth of many years. Below the purer peat are another 8 or 10 feet of peaty sand, and underneath this a layer of broken bones, burnt wood, and human implements.

The Bloemfontein Museum authorities heard of the find, and Mr. Leviseur authorised Professor Potts and myself to visit the spot. That the more important finds have been preserved we owe to Mrs. Martha Johanna Venter, the very intelligent wife of the farmer who lives at the spot. She has made a large collection of the bones and other remains, and though unfortunately she has allowed many of the human implements to pass into the hands of unscientific curiosity

hunters, her collection reveals all that is required for at least a preliminary note.

The animals whose remains have been found form a most interesting and varied fauna.

Equus capensis is represented only by a single tooth so far as I observed in looking over the collection.

Equus sp.—There are teeth of a small *Equus*—probably one of the small Zebras.

Hippopotamus amphibius.—The remains of *Hippopotamus* are abundant. Very fine tusks, teeth, and jaws are represented in the collection besides limb bones, etc. I do not think the *Hippopotamus* differs from the present-day species, and some of the specimens must have been of great size.

FIG. 2.—*Connochaetes antiquus.* Broom. × 1/7.

Phacochoerus aethiopicus.—There are many fragmentary jaws, tusks, and other bones of the Wart Hog.

Bubalus baini is represented by numerous specimens of horn cores, skulls, jaws, teeth, limb bones, and vertebrae. Most of the bones have been broken by human agency.

Connochaetes antiquus, n. sp.—The animal of which the remains seem most abundant is a new species of Wildebeest. In the collection are many horn cores. In type the horn is intermediate between that of the two surviving South African species. Like that of the white-tailed Wildebeest, there is a very prominent flattened backward process at the base of the horn. From the base the horn curves much more outwards in this new species, and then less abruptly upwards and backwards. The curving will be better understood from the illustration.

The greatest length of the core from the base to the outer curve in a straight line is 343 mm., and from the posterior knob at the base to the tip following the posterior curvature is 465 mm.

C. antiquus is so nearly intermediate between the two South African living forms that one wonders if it may perhaps be the ancestor of both.

Taurotragus oryx.—There are a number of bones of the Eland, including the frontal region with horn cores.

Cobus venterae, sp. nov.—There are many horn cores of a species of *Cobus*. It is somewhat intermediate between the Waterbuck (*C. ellipsiprymnus*) and the Lechwe (*C. leche*), but much nearer to

FIG. 3.—*Cobus venterae*. Broom. $\times \frac{1}{5}$.

the latter. From the existing Lechwe it differs in the curve of the horn and in the mode of implantation on the frontal bone.

Besides these readily recognisable forms there are remains of a number of small Carnivores and Ungulates, represented for the most part by teeth. Much work yet remains to be done in identifying these small forms. I failed to observe anything strikingly new, and probably most belong to existing species.

It is much to be regretted that the most interesting human implements have been scattered. The only two stone implements still left in the collection are a spear-head and a knife. The spear-head is 8 inches in length, about $2\frac{1}{8}$ inches in greatest width, and about $\frac{7}{8}$ inch thick at its thickest part. In section it is triangular, the flat side having a bulb of concussion, and the other side formed by the removal of two long flakes. The base has been trimmed by

the removal of another oblique flake, and by the formation of some small notches for the attachment of the spear-head to a wooden shaft. The other stone implement is evidently a knife. It is 5 inches in length. One side is flat and the other formed by the removal of three longitudinal flakes. Owing to incrustation from the hot spring the material of the implements could not be made out without chipping them.

Besides the stone implements there are a number of small wooden articles—pins, etc.—clearly shaped by human agency. And there are great quantities of burnt wood. Some of the logs are of large size, and show that there must have been much larger trees growing in the district than is now the case. I failed to detect any human bones in the collection. Possibly further exploration may reveal some. Till then some doubt must remain as to what human tribe lived in South Africa at the time of the Cape horse, the *Bubalus baini*, and the extinct Wildebeest.

5.—*On the Skeleton of a New Pareiasaurian* (Pareiasuchus péringueyi, g. et sp. nov.).—By R. Broom, M.D., D.Sc., and S. H. Haughton, B.A.

The almost complete skeleton described in this paper was found early in the year 1912 at the drift across the Zak River on the main Beaufort road on the farm Dunedin, in the division of Beaufort West. The skeleton was found *in sitû* on the side of a kopje, embedded in a comparatively hard mudstone. On extraction it was found that the limb bones of the left side were not present, and some of these were discovered at the foot of the kopje in a slightly weathered condition. Further, it was discovered that the whole of the right hind-limb was missing. On development, the animal showed signs of crushing, especially in the anterior region.

The skull is almost complete, and, with the exception of the atlas, there is a complete vertebral column from the axis to the 11th caudal vertebra. The shoulder girdle is complete, and only portions of the right innominate are missing from the pelvis. The right fore-limb is almost complete, the carpus and manus being fragmentary, and the left ulna was found weathered out together with the left femur and tibia. A large number of ribs were preserved, and the skeleton was covered along the back, ribs, and pelvis, by dermal ossicles, ranging in length from 15 mm. to 70 mm.

Skull.

The skull, though practically complete, is much crushed, and the bone so friable that perfect development is impracticable. And thus though it is possible to describe the general features we must wait for other specimens before we can give a full description of the Pareiasaurian skull in detail.

Though typically Pareiasaurian, this skull differs considerably from any of the known South African *Pareiasaurus* skulls, and it also differs from the very imperfectly known skull of *Propappus omocratus*.

The snout is broad and flat, and though the flattening is partly due to crushing, one need have no hesitation in saying that the snout

is twice as broad as deep. The nostrils are large and separated by a very feeble internasal process of the premaxillaries. Immediately behind each nostril is a distinct but small boss. With these exceptions the whole of the upper surface of the skull is characterised only by the typical Pareiasaurian sculpture. Even above the orbit there is only a rudimentary indication of a boss. The pineal foramen is large. There are no indications of the positions of the sutures of the upper cranial bones, and these could only be made out by seriously damaging the specimen. The total length of the skull from the snout to the middle of the occipital region is about 358 mm. From the middle of the snout to the back of the orbit is 230 mm.

The most noteworthy feature of the skull is the great size of the temporal roof. In the Pareiasaurs from the *Pareiasaurus* zone the quadrato-jugal region does not descend very greatly below the quadrate, and the angle of the region is almost as far back as the occiput. In this specimen the large quadrato-jugal portion passes far outwards and is turned much forwards, so that what is really its lower border makes an angle of about 120° to the maxillary edge. In this it agrees with the Russian Pareiasaurs obtained by Amalitsky. These Russian Pareiasaurs are probably from a higher zone than the South African species. They are associated with a large species of Dicynodon and with a number of large Therocephalians. Were such an associated fauna found in South Africa without *Pareiasaurus*, it would be referred to a zone very high in the Permian—possibly corresponding to our *Cistecephalus* zone. The Russian Pareiasaurs differ so much from our South African forms that it seems not improbable they will have to be placed in a different genus. In any case, the skull certainly resembles much more closely this South African *Pareiasuchus*, which is also probably as high as the *Cistecephalus* zone.

Almost the whole of the lower half of this great lateral bony plate is formed by the quadrato-jugal. At the lower angle is a huge rounded boss about 45 mm. in diameter. Immediately in front of this is a boss about half the size of the large one. Between this and the point where the quadrato-jugal meets the jugal the edge of the bone is slightly thickened and forms a prominent curve, which when viewed from the side looks like another boss. On the posterior border of the quadrato-jugal are three small bosses. The jugal is relatively a small bone which forms the lower border of the orbit and passes backwards some distance between the quadrato-jugal and the bone which is probably the postorbital.

Above the quadrato-jugal is a moderately large bone, which is pretty certainly the squamosal. If this identification be correct the arrangement of bones in the temporal region would agree essentially with the arrangement in *Procolophon*, *Diadectes*, *Captorhinus*, and most Cotylosaurs, and differ from that of *Pantylus* in having no prosquamosal. The arrangement of the bones in the occipital and postparietal region cannot be satisfactorily made out. There are two low bosses in the region corresponding to that formed by the post-temporal in *Procolophon*, and a third boss near what is apparently the lower end of the squamosal. Immediately above this last boss is a marked groove which curves round the border of the bone. There can be little doubt that this is the groove for the auditory canal.

The teeth are not very well preserved. In the upper jaw there seem to be 13 in each side. The teeth are relatively larger and flatter than in *Pareiasaurus*, and the cusps are either smaller or more rapidly worn down. In one tooth, probably the 12th, in which the crown is completely preserved, there are 13 cusps, of which the middle one is the largest, and they are arranged in a semicircle around the anterior half of the tooth. In the anterior teeth there are possibly 15 cusps.

The palate is not in good condition for showing the detailed structure. So far as can be seen it agrees closely with the *Pareiasaurus* palate photographed by Amalitsky. There is apparently a distinct transpalatine separated from the palatine by a large oval foramen. The large pterygoid is firmly fixed to the basisphenoid, and there is no possibility of movement.

The structure of the basicranium could not easily be made out without damaging the specimen.

The lower jaw is pretty well preserved. The anterior part is broad and massive. The splenial is strongly developed and forms most of the inner and lower half of the front of the jaw. The splenial appears to pass back as far as the plane of the middle of the large boss in the angular. The angular is massive, but is not of great antero-posterior length. On the lower border is a single, very powerful boss, which differs from the corresponding boss in *Pareiasaurus* in being, not hornlike, but slightly expanded at its end, which is flattened. In *Propappus omocratus* there are two hornlike processes. The articular is broad, but short. There appears to be a distinct but feeble prearticular or goniale. There is also apparently a distinct coronoid bone, but it and the surangular are not very well shown.

Remains of the hyoid apparatus are preserved, but not sufficiently satisfactorily to enable one to identify the elements with certainty.

Vertebral Column.

Of the vertebral column there is a continuous series of 33 vertebrae, ranging from the axis to the 11th caudal, and containing 18 praesacral, 4 sacral, and 11 caudal vertebrae.

The axis is complete, save for the neural spine, which is represented by a base 35 mm. long. The body of the axis is much shorter than those of the succeeding vertebrae, being 35 mm. in length. It is 40 mm. broad, and the total height of the vertebra to the base of the spine is 60 mm. The distance between the posterior zygapophyses is 50 mm. There is a short transverse process in the anterior half of the vertebra for the head of a short, apparently single-headed rib, which is almost on a level with the top of the body. Intercentra were probably present in all the cervical vertebrae, but were certainly small.

The 3rd and 4th cervicals agree in possessing bodies whose length is equal to the greatest width, neural spines strongly directed forward, and articular surfaces for double-headed ribs, one surface being a process in the anterior part of the middle of the centrum, and the other—the transverse process—just above the level of the body. The bodies of these vertebrae, and of the 5th cervical, are provided with a strong longitudinal ventral ridge, with slight excavations on either side. The zygapophyses are not so wide apart as in the dorsals.

The 5th and 6th vertebrae are displaced, but are provided with complete neural spines, which increase in thickness upward, and at the top contain a pronounced depression. Each spine is 47 mm. high. The 5th still possesses two articular surfaces for the ribs; but the 6th has the two surfaces fused for the articulation of a single-headed rib. The single surface projects as a strong plate beneath the prezygapophysis. The cervical ribs increase rapidly in size and strength up to the 7th, which is comparatively massive. Similarly the zygapophyses become wider apart and more strongly developed, the following being the width between the points of the postzygapophyses of the vertebrae up to the 8th:—2nd, 50 mm.; 3rd, 62 mm.; 4th, 63 mm.; 5th, 74 mm.; 6th, 94 mm.; 7th, 102 mm.; 8th, 120 mm. The 5th vertebra, which is the most complete of the cervicals (although somewhat crushed), gives the following measurements:—Length of centrum, 51 mm.; whole

height, 119 mm.; height of spine, 48 mm.; width between points of postzygapophyses, 74 mm.

The vertebrae from the 10th to the 19th are roughly similar, increasing gradually in size and strength backwards. The neural spines become longer and more regularly diamond shaped in section. The 16th to 19th inclusive differ from the others in that the centra in these are considerably wider than long. The following give the measurements of one of each of the typical vertebrae :—

12th (anterior dorsal): length of centrum, 59 mm.; width of centrum, 60 mm.; distance between points of transverse processes, 154 mm.; distance between points of postzygapophyses, 128 mm.

18th (posterior dorsal): length of centrum, 52 mm.; width of centrum, 65 mm.; whole height, 163 mm.; height of spine, 38 mm.; distance between points of transverse processes, 174 mm.; distance between points of postzygapophyses, 165 mm.

The articular surface for the 13th rib is 62 mm. long, while that for the 18th rib is 34 mm. long. The surfaces decrease in size on passing backwards.

The sacrum consists of four anchylosed vertebrae, differing thus from that of *Pareiasaurus serridens*, in which the sacrum is formed of two vertebrae only. The sacral vertebrae diminish in length and width from the first to the last, while the following give the heights :—Whole height: 20th, 138 mm.; 21st, 107 mm.; 22nd, 103 mm.; 23rd, 120 mm.; height of dorsal spine, 43 mm., 40 mm., 40 mm., 48 mm. respectively. The first sacral pleurapophysis is very massive. From the body of the vertebra to the ilium it measures 158 mm., while its articulation with the ilium measures 127 mm. in length. The articular surface is hollowed out into a deep groove, which accommodates the inwardly bent lower portion of the anterior part of the ilium. The second and third sacral ribs are comparatively small and thin, and apparently coalesce into a single thin plate above the posterior part of the articulation of the ilium and first sacral rib. The fourth sacral rib is stouter, being 82 mm. long and 50 mm. broad. The last three ribs seem to have been attached to the ilium partly by ligament.

The caudal vertebrae present are 11 in number, and decrease regularly in size: the 1st is 110 mm. high, the 11th 50 mm. The first six resemble the praesacrals in form, having similar dorsal spines and bodies. From each side of the centra of these six lateral processes are formed, the longest being 72 mm. long. Chevrons begin on the 7th caudal. The series is incomplete.

A fairly complete set of ribs is preserved. The largest measures

430 mm. in length, has an average height of 20 mm., and is about 15 mm. thick. The cervical ribs are displaced and thrust forward.

Shoulder Girdle.

Both sides of the girdle are well preserved, the left one being complete save for a small part of the precoracoid, and the right one lacking rather more of the coracoid and precoracoid. In general appearance the girdle resembles the known parts of *Propappus rogersi*, the chief differences lying in the smaller size of the glenoid cavity and the greater width of the scapula.

The scapula is anchylosed to both the coracoid and precoracoid, and with the former forms the whole of the glenoid cavity. This consists of two unequal parts, that formed by the scapula being the larger. At the anterior end of the cavity on the suture line there is an appreciable pit. The cavity is much smaller than in *Propappus rogersi*. The large precoracoid foramen is present, and the groove continuous with it in the scapula is very deep.

The coracoid is much thicker than the precoracoid, and is truncated at its posterior border.

The precoracoid is a thin, expanded bone which almost certainly forms no part of the glenoid cavity. The anterior border is thickened, but the whole of the lower border is missing.

The following are the principal measurements:—

Posterior end of coracoid to top of acromion	272 mm.
Greatest width of glenoid	82 ,,
Height of scapula above acromion	237 ,,
Width of scapula immediately above acromion	79 ,,
Thickness of scapula immediately above acromion	38 ,,
Width across top of scapula	124 ,,
Length of acromion	73 ,,
Maximum height of acromion	52 ,,
Distance between anterior and posterior borders of coracoid and precoracoid	197 ,,

The clavicles and interclavicle are almost complete. As in *Pareiasaurus serridens*, the clavicles fit into an irregular groove in the front of the lateral process of the interclavicle. They meet just in the middle line without fusion. The interclavicular process measures 245 mm. from side to side. The ventral process was probably about 200 mm. long, possessing an anterior median ridge proximally which dies away about half-way along the length. The

distal end is bi-lobed, possesses two main, low ridges, and is longitudinally striated.

There is no trace of a cleithrum.

Humerus.

The right humerus is almost complete, and well preserved, but somewhat crushed, while portions of the distal and proximal ends of the left humerus were found weathered out.

The greatest length of the right bone is 345 mm. The bone is greatly constricted in the middle, at its narrowest measuring 45 mm. × 40 mm. The shaft is rotated to a greater degree than in *Propappus rogersi*, but less than in *Pareiasaurus serridens*, the angle which the head makes with the distal end being about 45°—much the same as in *Propappus omocratus* (S.A.M. specimen).

The proximal end measures 184 mm. in breadth, and is comparatively flat. The delto-pectoral ridge is well developed, but shows none of the twisting so prominent in *Propappus rogersi*. The articular surface is long and narrow, and there is a well-marked ridge running on the outer surface of the bone from the anterior end of the articular surface to the constricted shaft.

The distal end differs both from that of *Propappus omocratus* and from that of *P. rogersi* in being much narrower, and in having the condyles much nearer together. The inner condyle appears to have been crushed, and is rather incomplete, but it forms a prominent narrow boss with a central ridge. The width across the distal end is 140 mm. The large rounded prominence for the articulation of the radius and ulna agrees in shape and position with that of *P. omocratus*. There is a well-developed entepicondylar foramen.

Radius and Ulna.

The right radius is perfect, and the proximal ends of both ulnae are present.

The radius consists of a straight columnar shaft with dilated ends, its length being 188 mm. The proximal end has an oval concavity, 79 mm. by 52 mm., about 16 mm. deep, and must have been supplied with a thick pad of cartilage. The inner end of the concavity is slightly prolonged. The distal end is irregularly triangular in shape with the front outer angle rounded. It measures 80 mm. by 55 mm., and altogether is more massive than the proximal expansion. At its narrowest the shaft measures 38 mm. by 30 mm.

The proximal part of the right ulna preserved measures 140 mm.

in length and 105 mm. at its greatest breadth. The olecranon process, so prominent in *Pareiasaurus baini*, is not developed to quite so great a degree, although it is much more pronounced than in *Pareiasaurus serridens*. The process which lies to the outer side of the head of the radius is triangular and has a base of 40 mm.

A number of isolated metacarpals and phalanges were found, but their positions had been considerably disturbed.

Pelvis.

The left innominate is practically entire, and there is a large portion of the right side. The pelvis shows differences from those of *Pareiasaurus* and *Propappus rogersi* and from that provisionally assigned by Lydekker to *Propappus omocratus*.

The axis of the ilium is directed more forwards and outwards than in *Propappus rogersi*, and the whole ilium is longer and of a more slender appearance. The crest is almost straight, 225 mm. in length, posteriorly being turned over a little inwards. Anteriorly the ilium is twisted, the anterior edge being turned outwards below, so that, from the front, the ilium appears to be almost horizontally flat. Internally the ilium is concave for the reception of the sacral ribs. Transversely it measures 90 mm., while in its narrowest part it measures 67 mm.

The acetabulum is shallow, and looks much more downwards than in *Pareiasaurus* or *Propappus rogersi*. It is smaller than that of the latter, its greatest width being only 97 mm., and its transverse measurement 86 mm. The greatest part of the acetabulum is formed by the ilium, which is anchylosed to the ischium. The sutures between the pubis and the other bones cannot be distinguished.

The distance between the anterior part of the symphysis and the point where the pubis probably joins the ilium is 165 mm. Downwards from the acetabulum the pubis is thickened and bent, as in *Propappus rogersi* and *Pareiasaurus*, forming a surface for the supposed cartilaginous prepubis. This surface is 85 mm. long and up to 24 mm. broad. The pubic foramen lies behind, and at the base of, this thickening, and is much narrower and deeper than the foramen in *Propappus rogersi*.

The ischium measures 165 mm. by 155 mm., and is quadrangular and plate-like in form. Posteriorly the corner is furnished with a short, outwardly directed process. The two sides of the pelvis are anchylosed along the symphysis, which is considerably thickened,

being about 60 mm. thick in the pubic region and thinning down to 20 mm. at the posterior end of the ischium.

Femur.

The left femur is beautifully preserved, and differs little in general appearance from the femur of the S.A.M. specimen of *Propappus omocratus*.

The chief measurements are as follows :—

	Pareiasuchus péringueyi.	*Propappus omocratus.*	*Propappus rogersi.*
Length of femur	320 mm.	335 mm.	290 mm.
Width of head	54 ,,	75 ,,	75 ,,
Length of head	126 ,,	117 ,,	112 ,,
Width of shaft at narrowest part	70 ,,	60 ,,	60 ,,
Width of distal end of bone ...	152 ,,	137 ,,	147 ,,

The chief differences, therefore, lie in the greater stoutness as compared with the femur of *Propappus omocratus*, and in the narrower, longer, and flatter head compared with both species of *Propappus*. The concavity between the lesser and greater trochanters is not so deep as in *P. omocratus*, and the lesser trochanter is less twisted. The face of the bone is of the usual Pareiasaurian type.

Tibia.

The left tibia is present, but it is so deformed by crushing that it is better to give no description of it.

Dermal Armour.

Dermal ossicles occur all along the back, between the proximal parts of the ribs, especially in the neck, and around the pelvis. The scutes are smaller than those of *Propappus*.

6.—*On a New Species of* Scymnognathus (S. tigriceps).—By R. Broom, M.D., D.Sc., and S. H. Haughton, B.A.

The magnificent specimen which forms the type of this new species was discovered about 3 miles WSW. of the homestead on the farm Dunedin, Beaufort West. It consists of the nearly perfect skull, a number of cervical vertebrae, the almost complete left fore-limb with the shoulder girdle and interclavicle. The discovery is one of much importance, as though hitherto we have known a good deal of the Carnivorous Therapsida of the *Pareiasaurus* and *Endothiodon* zones, and even more of the carnivorous types of the Upper Beaufort zones, we have known almost nothing of the carnivorous forms of the Middle Beaufort zones. Many types have been described by Owen, but they are nearly all imperfect snouts which give little evidence of their affinities. And for long we have been anxious to know whether carnivores of the *Cistecephalus* and *Lystrosaurus* zones were Therocephalians or primitive Cynodonts, or something distinct from either. The evidence we now have shows that they were neither typical Therocephalians nor Cynodonts, but Gorgonopsians.

When *Gorgonops* was first described by Owen in 1876 it was believed to be distinct from the other forms with mammal-like dentition, partly owing to an apparent peculiarity of the nose, and partly because the temporal region was believed to be roofed. Owen formed for it a special group—the *Tectinarialia.* Seeley and Lydekker have both agreed as to the roofing of the temporal region, and Seeley in 1895 made it the type of a distinct order—the Gorgonopsia. Three years ago it was shown by one of us (Broom) that a careful examination of the British Museum type shows that undoubtedly there is quite a large temporal opening, though the parietal region is broad. Still, *Gorgonops* one has always felt differed considerably from the typical Therocephalians. For a time it was suggested that it perhaps came nearer the Dinocephalians; latterly it has been placed with the Therocephalians for convenience. Now it seems more convenient to revive Seeley's order

or sub-order Gorgonopsia for *Gorgonops* and a number of other allied forms now known.

Gorgonops torvus is met with in the *Endothiodon* zone, and with it is a larger allied form, *Scymnognathus whaitsi.* In the *Pareiasaurus* zone a small Gorgonopsian has been found by the Rev. J. H. Whaits, and named *Scylacognathus parvus.* And it is thus interesting to note that while almost all the carnivores of the *Pareiasaurus* zone are Therocephalians, when we come to the *Endothiodon* zone Gorgonopsians are nearly as frequent as Therocephalians, and when we get up 2,500 feet higher Therocephalians appear to be absent, or at least much rarer than Gorgonopsians.

As has been shown in the paper describing *Scylacops*, the Gorgonopsians are probably the ancestors of both Anomodonts and Cynodonts, and being thus on the direct mammalian line all new facts concerning their morphology are extremely important.

Skull.

The skull is nearly perfect, though slightly crushed. It agrees closely with *Scymnognathus whaitsi*, though more powerful. From the snout to the back of the squamosal measures 310 mm., and the width across the zygomatic arches is 180 mm. The depth of the snout from the nasal to the mentum is 175 mm. The interorbital width is 80 mm., and the intertemporal 93 mm.

There is nothing of special note about the premaxilla or septomaxilla except that the latter is very large, and partly divides the anterior nares into upper and lower passages by a inwardly directed process or turbinal. There is also the usual outer foramen between the septomaxilla and the maxilla.

The maxilla is very similar to that in *Scymnognathus whaitsi.* It has a long posterior process which strengthens the suborbital arch and extends to opposite the middle of the base of the postorbital arch.

The teeth are remarkable. The dental formula is i 5, c 1, m 4 for the upper jaw. The incisors are all large except the last. They occupy a space of 50 mm. Then follows a diastema of 23 mm. in front of the canine, the antero-posterior diameter of which is 21 mm. Behind the canine is a diastema of 20 mm., and this is followed by 4 molars which occupy a space of 30 mm. The first three molars are larger than the 4th. All are simple pointed teeth, and we fail to observe any serrations. All the incisors and the canines have their points worn down, and this must have been done during the life of the animal. Further, this wearing could only have taken place when the jaws were widely opened, and whatever was the

cause of the blunting of the incisors the same was the cause of the wearing down of the canines. Probably *Scymnognathus tigriceps* preyed mainly on the contemporaneous *Pareiasuchus péringueyi* and the prehensile teeth became ground down by friction against the mud- and sand-crusted bony dermal plates during the struggles of the powerful Pareiasaurian with its enemy. The fact that the incisors and canines of the lower jaw are similarly ground down renders this theory very probable.

The sutures of the lachrymal and prefrontal are not very clear, but both bones are evidently fairly large. The jugal forms a very deep suborbital bar, and on passing back clasps the zygomatic portion of the squamosal.

The bones of the top of the skull resemble those of the more perfectly preserved Gorgonopsian—*Scylacops capensis.* The preparietal is in front of the pineal foramen, and the postfrontal is very well developed. The postorbitals and parietals are large, the former forming the upper borders of the temporal fossae.

The squamosal is very large, and remarkable chiefly by having the zygomatic portion clasped by an outer and inner plate of the jugal.

The interparietal is well developed and deep. It differs from that of *Scylacops* in having a very prominent median ridge. At the sides it meets the squamosal, and there is evidently no tabulare or other bone at the side of the occiput as in some Therapsidans. In many mammals there is a bone appearing on the lateral part of the occiput, which is apparently rightly identified as an opisthotic. What is possibly the same bone appears on the occiput of Cynodonts, and in the recent paper by one of us on the Cynodont skull it was referred to as the opisthotic. Whether it is in the Cynodont an opisthotic may be regarded as not yet proven, but that there is a distinct element here is beyond question. In Dinocephalians there is pretty certainly an element on the occiput which is neither squamosal, parietal, or interparietal. In Anomodonts, Therocephalians, and Gorgonopsians there does not appear to be usually at least any extra element, but in *Lystrosaurus* there is a small lateral bone which is evidently quite distinct from the parietal or squamosal.

The palate is well preserved and very interesting. The basisphenoid is somewhat Anomodont in character. It passes down considerably below the level of the basioccipital, and forms a deep median ridge which in front meets the median ridge formed by the two pterygoids. Above, the basisphenoid forms a median septum which passes upwards and forwards to near the front of the orbital region.

The pterygoids are large bones. They form behind part of the median descending ridge. Postero-laterally a process is sent to meet the quadrate and also to support the columella cranii. Each pterygoid also forms a huge descending pterygoid process. In front the development of the pterygoid is slight. It meets the transpalatine and the palatine. Superiorly the pterygoid forms a large thin paramedian plate not unlike that seen in the pterygoid of the Pelycosaurs. The huge median bony septum is probably formed by the two pterygoid plates anchylosing with a median plate formed by the basisphenoid or ethmoid. In section no sutures can be made out, but the outer wall of the septum is unquestionably pterygoid. In the allied *Scylacognathus parvus* the pterygoids have probably had cartilage between them, as they are not anchylosed to form a septum.

The palatines form a large part of the palate, and send up paraseptal plates, as do the pterygoids.

The vomer is a true median vomer, as in the Anomodonts, the Cynodonts, and Mammals. It is a large thin plate which divides the nasal space into two. The greater part of the bone is thin, but the lower border which formed part of the roof of the mouth is fairly strong and broad.

There appears to be no trace of paired prevomers.

The quadrate is fairly large, and in its relations to the squamosal not unlike that of the Cynodonts, but relatively very much larger. There appears to be no trace of a quadrato-jugal.

The stapes is long and fairly strong.

The lower jaw is in beautiful condition, and all the elements can be satisfactorily made out.

The dentary is as usual the largest bone. It has a very powerful, deep symphysis. It is not yet known for certain, but it seems not improbable, that all those supposed Therocephalians with a powerful, deep symphysis will prove to be Gorgonopsians. It is pretty certain at any rate that those carnivorous Therapsida with a feeble, loose symphysis are true Therocephalians. The coronoid process is fairly well developed, but shorter than in typical Therocephalians.

The splenial is large. It forms much of the lower part of the symphysis and most of the inner side of the front half of the jaw.

There is a distinct coronoid bone. It is a thin triangular splint that supports and holds together parts of the dentary, the surangular, the angular, and the prearticular.

The angular is the second largest bone of the jaw. In front it passes between the splenial and the dentary, and extends nearly to the symphysis. Posteriorly it forms most of the lower half of the

jaw. A considerable part of its inner surface is covered by the surangular, a large part by the prearticular, and a small part by the coronoid. The bone is divided on its lower aspect by a deep groove, as in the Pelycosaurs.

The surangular resembles that bone in Anomodonts and Therocephalians.

The prearticular is a long slender splint bone. Posteriorly it clasps the articular, and in front lies mainly on the angular, and also articulates with the dentary, the coronoid, and the splenial. Anteriorly it reaches to the molar region.

The articular is a short strong bone. It is supported by the angular, the surangular, and the prearticular.

Vertebrae.

The proatlas is a well-developed paired element. Each half is irregularly rhomboidal. It articulates with the atlas.

The atlas is formed as in Pelycosaurs, Dinocephalians, and Anomodonts—a pair of upper arches and a lower centrum which forms the odontoid process of the axis. Each half of the arch has a small zygapophysis for articulation with the axis and a transverse process which supports the atlantal rib.

The body of the axis is 38 mm. long and 30 mm. broad. The width across the posterior zygapophyses is 38 mm. The neural spine is elongated anteriorly, diminishing in height in the same direction. Its greatest length is 56 mm. and its greatest height 40 mm.

There are four other cervical vertebrae preserved, similar to each other and characterised by a short, rounded body, a long transverse process which forms the articular surface for a single-headed rib, and a low dorsal spine. The third of these vertebrae, which is typical, has the following measurements :—Length of body, 29 mm.; greatest width of body, 37 mm.; total height, 62 mm.; height of spine, 11 mm.; width across transverse processes, 85 mm.; width across postzygapophyses, 29 mm.

Shoulder Girdle.

Both right and left sides of the shoulder girdle are present, the only parts missing being the right clavicle, part of the left coracoid, and the distal end of the interclavicle. The sutures between the coracoids and precoracoids are almost obliterated, but there seems no doubt that the usual three elements are present, and that the

girdle resembles the Therocephalian type as seen in *Ictidosuchus primaevus*.

The scapula has a broad lower end, and forms the upper half of the glenoid cavity, which half is almost a plane surface bounded by rather more than a semicircle. In its length it is curved backwards and inwards. The precoracoidal foramen is seen passing down from the inner side of the scapula, where it forms a moderately deep groove, and appears on the outside just below the suture between the scapula and precoracoid. The right precoracoid was found broken in such a way as to show the position and direction of the precoracoidal canal. The scapula possesses no acromion process, and there is no trace of a cleithrum. As a loosely articulated cleithrum exists in the allied *Scylacops capensis* it is more probable that it has been lost than that none existed.

The coracoid forms the lesser and lower half of the glenoid cavity, the glenoid surface being concave, looking upwards and outwards, and being separated from the outer side of the bone by a prominent ridge. Posteriorly, the subglenoid portion is prolonged into a process which curves slightly upwards and whose thickness rapidly diminishes. On the left coracoid this process has been compressed upwards and backwards.

The precoracoid is a thin plate-like bone which is anchylosed with both the other elements. It is slightly smaller than the coracoid. The suture between the two ventral elements appears to be a straight one, and the precoracoid appears to form no part of the glenoid cavity.

The chief measurements are as follows :—

Greatest length of scapula	130 mm.
Width of base of scapula	80 ,,
Width of top of scapula	49 ,,
Greatest width of glenoid	43 ,,
Greatest height of glenoid	48 ,,
Length of precoracoid—coracoidal suture	70 ,,
Length of coracoidal process behind glenoid	84 ,,
Distance between anterior and posterior edges of precoracoid	64 ,,

The clavicle is a slightly curved bone, flattened from above at its upper end, oval in the middle, and expanded into a wide, flat plate at its articulation with the interclavicle, being thickest there anteriorly, and thinning out to about 1 mm. behind. The two clavicles do not meet. The total length of the left clavicle is 200 mm., and the greatest width at the proximal end 45 mm.

The interclavicle is an elongated, truncated-triangular-shaped bone about 220 mm. long and 80 mm. broad at its posterior end, thin, slightly convex on its upper surface, and provided with a pronounced ridge on its under surface. This ridge dies away distally and proximally from an apex in the centre. From the ridge the ventral surface slopes to left and right, and over these sloping surfaces the clavicles seem to have been able to move with a certain amount of freedom.

Humerus.

Both humeri are complete and in a beautiful state of preservation. The shaft is not greatly twisted, the planes of the two ends of the bone lying at an angle of about 30° with each other; but the lower portion of the proximal angle is further bent until its plane makes an angle of about 70° with that of the distal end.

The greatest length of the bone is 246 mm.; the proximal end is 125 mm. wide; the distal end 113 mm. wide; while the narrowest part of the shaft measures 31 mm. in diameter.

The proximal end is thickened at the articular surface, while the lower twisted portion is comparatively thin. Anteriorly there is a well-marked ridge running outwards from the lower end of the articular surface; this ridge can be traced along the shaft, and becomes very prominent on the distal portion of the bone. The articular surface of the proximal end is elongate-oval in shape, widest at the middle, measuring 83 mm. in length and 38 mm. at its greatest breadth. From a median longitudinal ridge it slopes away on either side in a slightly convex curve. The delto-pectoral ridge is not very pronounced, and there is a shallow concavity above it.

At the distal end the inner side of the bone is pierced by the entepicondylar foramen, which passes from behind downwards and forwards. A well-defined groove running outwards from the upper end of the foramen gives rise to two prominent bounding ridges to the bone in this region, the bridge being very pronounced. The foramen, which is oval in shape and has a longer diameter of 21 mm., is situated 76 mm. from the distal end. Another groove runs from it along the under surface, between the border of the bone and the inner condylar boss.

In general shape the humerus agrees with that figured by Owen as "Cynodrakon major," but it differs from this chiefly in the shorter and wider proximal portion which it possesses, in the greater rotation of the shaft, and in the shape of the proximal articular surface.

Radius and Ulna.

The bones of both sides are present, those of the left being found *in sitû* in connection with the humerus, and but slightly displaced from their natural positions.

The radius is 155 mm. in length, expanded at its two ends, and 19 mm. in diameter at its narrowest. Proximally, the articular surface is elongated slightly in the direction of the ulna, and is slightly concave. It is 50 mm. long and 40 mm. broad. From the proximal end a ridge runs down the ulnar side of the bone; on the opposite side the shaft is flattened; so that in section the shaft is markedly triangular at its middle point, with the two anterior angles rounded. The distal articulation is almost circular in section, measuring 40 mm. in diameter, and is convex.

Only the proximal ends of both ulnae are preserved. The articular surface measures 44 mm. in length and about 37 in breadth. There is no well-developed olecranon process for wrapping round the humerus. Distally, the bone becomes thinner, and 80 mm. from the proximal end has an average thickness of only 11 mm.

Manus.

The manus of the left side is almost complete, and the bones are preserved in position and in connection with the radius and ulna. We are thus for the first time in a position to give a complete account of the Gorgonopsian carpus, metacarpus, and phalanges.

The most striking feature of the carpus is its resemblance to that of the Pelycosaurs and its less striking resemblance to that of either the Anomodonts or the Dromasaurians. This manus also sets at rest all doubt as to the Therocephalian digital formula. Formerly it was believed to be 2, 3, 3, 3, 3, but two years ago it was shown by one of us that the formula almost certainly was 2, 3, 4, 5, 3, there being two very short epiphysis-like phalanges in the 4th digit and one short phalanx in the 3rd digit. We now see that this is correct, and that the formula is as in the Pelycosaurs 2, 3, 4, 5, 3, and not as in the Dromasaurians, Anomodonts, and Cynodonts 2, 3, 3, 3, 3.

The radiale articulates apparently with the whole of the distal end of the radius. Though relatively short it is wide and deep. Distally it articulates with both the centralia, and when the manus is flexed also with the 1st carpal.

The ulnare is comparatively flat and much longer than narrow. Proximately it articulates with the ulna and the intermedium, and possibly also with a small pisiform. Distally it articulates with the

fused 4th and 5th carpalia, and its inner side articulates with the outer centrale.

The intermedium is imperfectly preserved, but was pretty certainly small. As preserved it lies between the radius and ulna.

The two centralia are of about equal size. The outer is irregularly cubical, and lies between the radiale and ulnare. The inner lies between the radiale, the outer centrale, and the 1st and 2nd distal carpalia.

There are apparently four distal carpals, but there is good reason for believing that what is apparently the 4th is really the 4th and 5th anchylosed.

The 1st distal carpal is a comparatively flat bone somewhat broader than long, and it gives articulation to the first metacarpal. At its outer and posterior corner there lies a small distinct bone which is unfortunately imperfectly preserved. This may be regarded as a radial sesamoid or prepollex.

The 2nd distal carpal is a small cubical bone, much thicker than the 1st, and it gives articulation to the 2nd metacarpal.

The 3rd distal carpal is when viewed from above also small, but it is very thick. It supports the 3rd metacarpal.

The combined 4th and 5th distal carpalia is a large bone nearly twice as wide as long. It is not so thick as either the 2nd or 3rd. What makes it pretty certain we are dealing with two bones and not one are the following characters :—A ridge divides the bone into an outer and inner half, and the bony fibres of the inner half at least can be seen radiating out from the centre of this inner half, and further the two halves have each a distinct group of nutrient foramina. The combined bone supports the 4th and 5th metacarpals.

The 1st metacarpal is very imperfectly preserved. It evidently was broad and flat.

The 2nd metacarpal is a short bone only a little longer than broad. The distal end seems to indicate that the 1st phalanx could be considerably overextended.

The 3rd metacarpal is nearly twice as long as broad, and the 4th metacarpal is nearly three times as long as wide.

The 5th metacarpal is comparatively flat and broad. It is less than twice as long as broad.

The phalanges of the 4 outer toes are almost perfectly preserved. In the 2nd digit the 1st phalanx is comparatively short—only a little longer than broad, and it is rather flat. The second phalanx is also

short and broad. The ungual phalanx is long and powerful, but not greatly curved. It manifestly had a powerful claw.

The 3rd digit has the 1st phalanx short and powerful, almost as broad as long. The 2nd phalanx is very short, its length being only about $\frac{1}{3}$ of its width. Though so very short it manifestly has hinged freely on both the 1st phalanx and the 3rd. The 3rd phalanx is a strong short bone about as long as broad. The ungual phalanx is like that of the 2nd toe, long and powerful, and only slightly curved.

The 4th digit has the 1st phalanx short and powerful, very little longer than broad. Following it are two short plate-like phalanges agreeing closely with the short phalanx in the 3rd toe. Each is only about $\frac{1}{3}$ as long as broad, and each seems to have very free movement. The 4th phalanx is much like the penultimate phalanges of the other toes. The ungual phalanx is also similar to that of the 2nd and 3rd toes.

The 5th digit has only three phalanges—the 1st and 3rd like the proximal and distal phalanges of the other toes, and the middle phalanx like the penultimate phalanges of the others.

It will thus be seen that though the digital formula is 2, 3, 4, 5, 3, the 3rd and 4th toes have been shortened by the 2nd phalanx in the 3rd toe, and the 2nd and 3rd phalanges in the 4th toe becoming very much reduced in size.

Considering the width of the foot the toes are short. The extent of movement of the bones is not quite clear. Probably the animal walked with the foot mostly on the ground after the manner of the bear. Considerable movement seems to have been possible between the carpals and metacarpals, and more between the metacarpals and phalanges. Considerable flexion of the claws on the palm was possible, but the whole hand can only be regarded as a very imperfect instrument of prehension.

As it is pretty certain that both the Anomodonts and the Cynodonts are descended from a Therocephalian ancestor, it would be very interesting to find out exactly how the 2, 3, 3, 3, 3 digital formula was derived from the 2, 3, 4, 5, 3 formula of the Therocephalian. We see clearly one stage—the great reduction in length of the 2nd phalanx of the 3rd toe and of the 2nd and 3rd phalanges of the 4th toe, but at present we have no evidence as to whether these reduced phalanges became further steadily reduced or suddenly disappeared. The latter seems the more probable alternative.

7.—*On Two New Species of* Dicynodon.—By R. Broom, M.D., D.Sc., and S. H. Haughton, B.A.

Dicynodon testudirostris, sp. nov.

The type of this new species (No. 2354 S.A.M.) was collected at Dunedin, Beaufort West, just south of the Homestead, and is probably from the *Cistecephalus* zone. It is a small skull of a female, measuring in greatest length 85 mm., or, allowing for slight crushing, probably originally 90 mm. The greatest breadth is 56 mm. From the snout to the front of the orbit is only about 18 mm. when the skull is viewed directly from above. The orbit is about 20 mm. in length, and from the front of the postorbital arch to the back of the squamosal is about 47 mm.

Two specimens were discovered near the same spot, which agree closely. Both are tuskless, and would formerly have been placed in the genus *Oudenodon*, but we now know that this is the female of *Dicynodon*. In a number of respects the present species differs remarkably from the *Dicynodons* of a lower horizon, and it will probably be necessary to break up the genus later on. At present, however, we do not know enough safely to do so, and for a time we may conveniently place all in the old genus *Dicynodon*, even though the number of species is becoming large.

The beak is very short, and the caniniform process lies under the middle of the orbit. The arrangement of bones round the nostril is remarkable. The premaxilla is, as always in *Dicynodon*, unpaired. It is flattened in front and rounded at the sides. It passes up between the nostrils and between the nasals. The maxilla, though not large, forms practically the whole of the cheek. It almost reaches to the orbit, hiding the jugal and lachrymal except just at the orbital margin. It forms the anterior margin of the nostril and has a fairly long articulation with the nasal.

There is no evidence of a septomaxillary, at least on the outer side of the skull. Whether there may be one hidden underneath it is impossible to say without damaging the skulls. We incline, however, to think that the septomaxillary is absent. Formerly it was

believed to be absent in *Dicynodon.* Then it was clearly seen in one or two specimens. Probably we shall find that in some species it is present and in others absent.

The nasal is fairly large, and has a large articulation with the frontal, the maxillary, and the premaxillary.

The lachrymal and prefrontal are much reduced. Probably the lachrymal is considerably hidden by the nasal and maxilla, but the prefrontal can only be regarded as quite rudimentary. In many species of *Dicynodon* it is a large bone, and the great reduction here seems to suggest an affinity with *Cistecephalus*, where it is also rudimentary.

The frontal is large and forms most of the upper margin of the orbit. The postfrontal is present, but very small though fairly long.

The postorbital is very large, and besides forming the whole of the outer part of the postorbital arch it forms almost the whole of the upper margin of the temporal fossa. The pair of postorbitals form a large part of the upper surface of the skull, meeting each other behind the pineal foramen and covering most of the parietals.

The preparietal is fairly large and almost entirely in front of the pineal foramen, only a minute portion of the bone touching the front of the foramen.

The parietals are well seen on each side of the foramen and in front of it, but are mainly hidden behind by the postorbital.

The squamosal is of usual type and presents no specially noteworthy features. The quadrato-jugal is very large, and apparently not anchylosed to the quadrate, as is usually the case.

The palate has not been fully displayed in either of the specimens, but so far as can be seen is of the normal *Dicynodon* type.

Dicynodon alticeps, sp. nov.

The skull on which the following description is based was collected about one mile west of Oudeberg, in the division of Graaff Reinet, on the main road cutting between Murraysburg and Graaff Reinet. Although crushed and slightly distorted, and imperfect in the zygomatic arches and the tip of the snout, the skull is in a good state of preservation.

In general appearance the skull resembles *Dicynodon leoniceps*, but besides being much smaller, it differs from Owen's species in a number of important particulars sufficient to warrant us in the erection of a new species.

The snout is inclined at an angle of about 50° to the plane of top of skull.

The suture between the maxillaries and the premaxillary is indeterminable. The maxillae are fairly large bones, forming most of the snout behind the nostrils, which are roughly circular and about 24 mm. in diameter. Posteriorly the maxillae have suborbital portions which articulate with the jugal and meet the anterior process of the squamosal. The caniniform processes are found just behind the plane of the back of the nostrils, and the tusks, which are incomplete, curve downwards, forwards, and very slightly inwards—the general direction, however, being slightly more forwards than in *D. leoniceps.*

The nasals form the border of the upper posterior quadrant of the nostrils, and, passing backwards, are apparently separated from one another, save near the frontals, by the internasal process of the premaxilla.

The septomaxillary cannot be discerned.

The lachrymal forms a portion of the face about 35 mm. long and 12 mm. broad, and near its lower end forms a small boss on the border of the orbit. Anteriorly, the lachrymal advances almost to the nostril.

The prefrontal is larger than the lachrymal and forms a prominent supraorbital boss, which is the anterior part of the supraorbital ridge.

The frontal forms about 25 mm. of the upper border of the orbit, and apparently passes backward in a slender prolongation to behind the plane of the pineal foramen. The postfrontals are not well-defined, but they appear to be fairly large bones.

The postorbital forms almost the whole of the outer part of the postorbital arch, besides extending over the length of the inner wall of the upper margin of the temporal fossa. Nowhere, however, do the pair of bones meet.

The pineal foramen is fairly large, situated a short distance behind the front of the temporal fossa, and is wholly enclosed by the preparietal. Immediately behind the foramen is a small, elongate boss. The preparietal is about 30 mm. long, and extends as much behind as before the pineal foramen.

The parietals extend forward to a point just anterior to the back of the pineal foramen. The parietal region consists of a fairly deep groove bounded by the outer margins of the parietals and the postorbitals. The total length of the parietal is 37 mm.

The squamosal is a large bone, not wholly perfect, in which the curve between the zygomatic and downward portions is more regular and not so markedly angular as in many other species. The relations of the squamosal with the occipitals is not displayed. Quite a large

proportion of the upper and inner portion is covered by the postorbital. The zygomatic portion passes forward to a point below the orbit, where it comes to an end between the maxilla and the jugal. The downward portion is attached at its lower end to the quadrate, and also supports the large quadrato-jugal plate.

The palate, although not fully developed, appears to be of the normal type.

The following are some of the chief measurements:—

Greatest length	242	mm.
Greatest breadth .... probably	170	,,
Snout to front of orbit	67	,,
Length of orbit	48	,,
Minimum width between orbits	42	,,
Minimum width of temporal roof	18	,,
Front of postorbital arch to back of squamosal...	127	,,
Maximum height of skull	115	,,
Maximum width of lateral plate of squamosal probably	35	,,

The chief features, therefore, lie in the height of the skull, in the rather large size of the orbit, the extended postorbital, and the large ratio (7 : 3) between the frontal and temporal widths.

8.—*On a Skull of* Tapinocephalus atherstoni, Owen.—By S. H. Haughton, B.A.

Recently the South African Museum was presented with a skull, without the lower jaw, by Mr. P. Le Roux, of Uitkyk, in the Gouph district of Beaufort West, by whom other Dinocephalian bones have been donated in the past. This skull almost certainly belongs to *Tapinocephalus atherstoni*, and is the only skull we yet possess.

Fig. 4.—*Tapinocephalus atherstoni*, Owen.
Top view of skull. × 1/6

Tapinocephalus atherstoni was described by Owen in 1876 from an imperfect snout sent by Dr. W. G. Atherstone from Jan Willem's Fontein, Prince Albert District. A large number of other bones were sent by Atherstone at the same time, but these bones have apparently got mixed, and some of them were figured by Owen as bones of *Pareiasaurus*. From the Brit. Mus. Catalogue there would appear to be nearly a whole skeleton of *Tapinocephalus*—all bones sent by Atherstone in 1872. Some of the bones are said to come from Gats-Plaatz, others from Vers Fontein, but as there is admittedly some doubt about some of the localities, and as no bone occurs in

duplicate, one suspects that all the bones are from one locality and of one individual. In 1909 Broom described a Dinocephalian skull in the possession of the British Museum under this same specific name. Dr. Broom now informs me, however, that it is almost certain that this latter skull, howbeit a Dinocephalian, is not *Tapinocephalus atherstoni*, although closely allied to that species.

The greatest length of the skull under description is 530 mm., while the distance from the occipital condyle to the front of the snout is 435 mm. The maximum width of the skull is equal to its length, while its height in the temporal region is 285 mm. It consists of a large, high, broad, rounded temporal and posterior portion and a flat, broad snout. The frontals rise abruptly from the nasals almost at right angles.

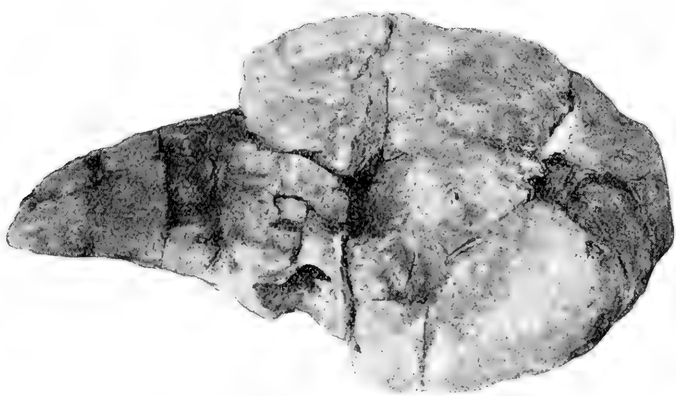


Fig. 5.—*Tapinocephalus atherstoni*, Owen. Side view of skull. × $\frac{1}{6}$

Owing to the weathered condition of the surface of the skull, and the hardness of the matrix, the sutures between the bones are not easy of determination. Fortunately, however, on arrival at the Museum the skull was found to be broken in several pieces, a fact which has materially assisted in the working of the skull. The palate is very well displayed.

The premaxilla was comparatively small, and bore teeth, as did the maxilla. Most of the teeth are lost, and the number is indeterminable. Just behind the junction between the premaxilla and maxilla of the left side there is a portion of a large tooth, and, internal to it, is a small secondary replacing tooth, circular in section, 5 mm. in diameter.

The maxilla is large, moderately flat, and carried teeth. Its

posterior limit cannot be seen. The septomaxillary is well displayed. It lies along the floor of the nostril and ascends to form a small part of the face. As pointed out by Broom, this is the bone which was described by Owen as the palatine.

The orbit is large and round, and looks outwards, upwards, and slightly forwards. The supraorbital border overhangs it to a certain extent, and behind, the postorbital arch is very strong. The limits of the lachrymal and prefrontal are not well-defined, but both seem to be present, and the lachrymal the larger of the two. The jugal, which forms the lower border of the orbit, is a flat bone, relatively small, which passes backwards to meet the squamosal.

It is impossible to define the quadrato-jugal.

The temporal fossa is small, and is directed outwards and backwards. Its anterior, and almost the whole of its superior, border appear to be formed by the postorbital, while the squamosal bounds the inferior and posterior sides. The squamosal is of the normal Dinocephalian type, meeting the parietal, the quadrate, and the jugal by means of three processes.

The frontals and parietals are very much thickened, and the whole of the top of the skull is very broad. Just behind the plane of the back of the orbit the temporal region is slightly hollowed, with a slightly raised boss in the centre of the hollow. This is probably the pineal region; but the pineal foramen is apparently almost, if not entirely, covered with bone.

The occiput is fairly flat and large and slopes backwards and upwards. The condyle is rounded, 55 mm. wide, and on its upper side has a deep groove for the medulla. This groove is about 25 mm. broad and half as deep. In the middle line below the medullary groove is a pit 25 mm. broad. There is a large exoccipital which touches the squamosal and quadrate. The stapes is elongated posteriorly in the direction of the quadrate.

The structure of the palate is essentially that given by Broom in describing the British Museum skull. There is no trace of a transpalatine.

In addition to those given above, the following are some of the chief measurements:—

Distance from occipital condyle to front of snout	435	mm.
Length of snout..	220	,,
Distance from quadrate to front of snout	290	,,
Breadth of palate at posterior end of prevomers	280	,,
Length of prevomers...................................	145	,,

9.—*On a New Species of* Propappus.—By S. H. Haughton, B.A.

The pelvis which forms the type of this new species was discovered by me at the drift across the Zak River on the main Beaufort road, on the farm Dunedin, in the division of Beaufort West. In conjunction with it were found a number of vertebrae and ribs, together with some dermal ossicles.

A large portion of the right innominate is preserved, including the whole of the ilium, the acetabulum, and the anterior portions of the ischium and pubis. The ilium differs considerably in shape from that of any other South African Pareiasaurian. The crest is short, with its anterior part curved outwards in a quarter-circle, in such a manner that there is a marked concavity at the anterior end of the ilium. The straight part of the crest measures 120 mm. in length, while the whole length is about 170 mm. The greatest height of the ilium is 115 mm., while the distance from the top of the acetabulum to the most anterior part of the pelvis is 185 mm. The neck of the ilium is greatly constricted, measuring only 43 mm. in height and 23 mm. in thickness at its narrowest part.

The acetabulum is distinctly oval in shape, the longer axis lying along the suture between the ilium and the posterior bones, shallow except for the development of the upper iliac and upper ischial border. Its height is 90 mm., and its greatest width 57 mm. More than half the acetabulum is apparently formed by the ilium, about one-sixth by the pubis, and the remainder by the ischium; but the sutures between the bones can be traced only with difficulty and in part. The acetabulum looks downwards and outwards.

The ischium displays a shape very different from that of any other Pareiasaurian. In *Pareiasuchus* there is a well-marked tuberosity at the posterior corner, and there is a smaller one in *Pareiasurus serridens*; but in this specimen the tuberosity is a large, thickened process, the anterior border of which is at right angles to the upper border of the ischium. The shape and size of this can best be understood from reference to the figure. The

lower half of the posterior border of the ischium is missing, but below the protuberance the border thins rapidly.

The pubic foramen occupies relatively the usual position. The thickening for the pre-pubic cartilage, so prominent in other Pareiasaurians, is not present here. Downwards from the acetabulum the pubis is bent slightly backwards, but its thickness reaches only 10 mm.

The sacral ribs, apparently four in number, fitted into a very shallow groove on the inside of the ilium. The first, which was much expanded distally, seems to have given support by curling round the lower border of the ilium. The second and third ribs were fairly stout.

The shape of the ilium and of the acetabulum, the large ischial protuberance, the absence of the thickened pubic brim, and the diminutive size are all new features displayed by this pelvis, and serve to distinguish it from any hitherto described Pareiasaurian.

The vertebral remains consist of a series of six dorsal vertebrae, and a number of connected caudal vertebrae.

The dorsal vertebrae are possibly the 12th to 17th inclusive, and are characterised mainly by the shortness of the neural spines, and the general size, which is less than that of any known Pareiasaurian vertebrae, with the exception of those of *Anthodon*. Those preserved differ but little from one another. The centra are as long as they are broad, but constricted considerably in the middle, so that they have an elongated appearance. On the lower side both ends of the body are truncated obliquely, so that, although no intercentra are preserved, they were probably well developed. The following measurements of what is possibly the 13th may be taken as typical of these dorsal vertebrae:—Total height of vertebra, 107 mm.; width across transverse processes, 120 mm.; length of centrum, 41 mm.; height of spine above junction of postzygapophyses, 18 mm. The transverse process is continued downwards and forwards to the front of the body, and gives rise to a surface, 52 mm. long, for the articulation of a single-headed rib. From the transverse process the anterior zygapophysis is formed, lying at about the level of the top of the body.

There is a continuous series of eleven caudal vertebrae, comprising probably the 5th to the 15th inclusive. The bodies of the first three of the series differ from those of the praesacral vertebrae in that they are not medially constricted. The total height of the 2nd of the series is 56 mm.; the body is 24 mm. long; the width between the points of the postzygapophyses is about

40 mm.; and the spine is 15 mm. high. The vertebrae diminish in size backwards, the height of the penultimate being 40 mm., and the maximum width across the transverse processes 29 mm. The spines are short, and directed backwards. Chevrons begin after the 3rd of the series and are continued to the end.

The dermal ossicles are comparatively large, and were very plentifully scattered over the back and ribs of the animal. The largest of them reached a diameter of 55 mm., which is a greater size than is seen in the larger animal *Propappus omocratus*. They have the typical shape and sculpture of the normal *Propappus* ossicles.

Dr. Broom has kindly examined the specimen for me, and confirms my opinion that it must be regarded as a new species. For it I propose the name *Propappus parvus*, sp. nov.

EXPLANATION OF PLATES.

PLATE I.

FIG.
1. *Caruichthys ornatus*, Broom. × $\frac{1}{2}$.
2. *Atherstonia cairncrossi*, Broom. × $\frac{1}{2}$.

PLATE II.

1. *Palaeoniscus capensis*, Broom. × $\frac{1}{2}$.
2. *Elonichthys whaitsi*, Broom. × $\frac{1}{2}$.

PLATE III.

1. *Pareiasuchus péringueyi*, Broom and Haughton. Posterior view of the left shoulder blade. × $\frac{1}{5}$.
2. *Pareiasuchus péringueyi*. Outer view of left shoulder blade. × $\frac{1}{6}$.
3. ,, ,, Anterior view of right humerus. × $\frac{1}{6}$.
4. ,, ,, Posterior view of right humerus. × $\frac{1}{6}$.
5. ,, ,, Anterior view of right radius. × $\frac{1}{6}$.
6. ,, ,, Anterior view of proximal half of right ulna. × $\frac{1}{6}$.

PLATE IV.

1. *Pareiasuchus péringueyi*, Broom and Haughton. Posterior view of left femur. × $\frac{1}{6}$.
2. *Pareiasuchus péringueyi*. Anterior view of left femur. × $\frac{1}{6}$.
3. ,, ,, Outer view of left side of pelvis with sacral rib. × $\frac{1}{6}$.
4. ,, ,, Lower view of left side of pelvis with sacral rib. × $\frac{1}{6}$.
5. *Propappus parvus*, Haughton. Outer view of right side of pelvis. × $\frac{1}{4}$.

PLATE V.

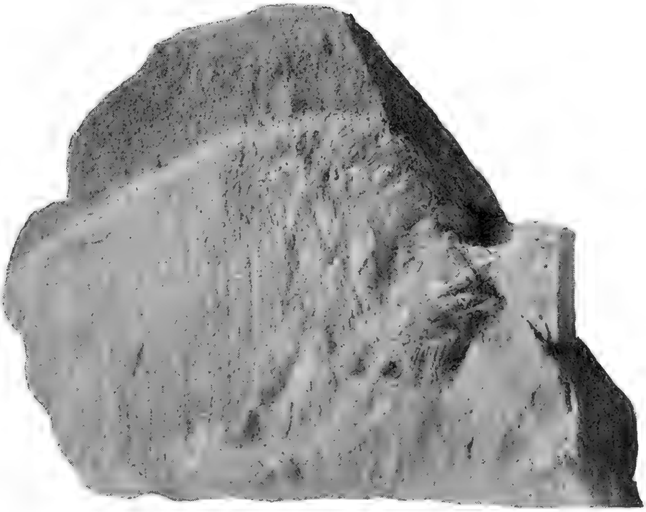
Pareiasuchus péringueyi, Broom and Haughton. Mounted skeleton. × $\frac{1}{10}$.

PLATE VI.

1. *Scymnognathus tigriceps*, Broom and Haughton. Side view of skull. × $\frac{1}{3}$.
2. ,, ,, Side view of left side of shoulder girdle, left clavicle, and interclavicle. × $\frac{1}{2}$ nearly.
3. ,, ,, Right side of shoulder girdle. × $\frac{1}{2}$ nearly.
4. ,, ,, Anterior view of left fore-limb. × $\frac{1}{3}$ nearly.
5. *Scylacops capensis*, Broom. Top view of skull. × $\frac{1}{2}$.

PLATE VII.

1. *Dicynodon alticeps*, Broom and Haughton. Side view of skull. × $\frac{1}{2}$ nearly.
2. ,, ,, Top view of skull. × $\frac{1}{3}$.
3. *Dicynodon testudirostris*, Broom and Haughton. Top view of skull. × $\frac{2}{3}$.
4. ,, ,, Side view of skull. × $\frac{2}{3}$.



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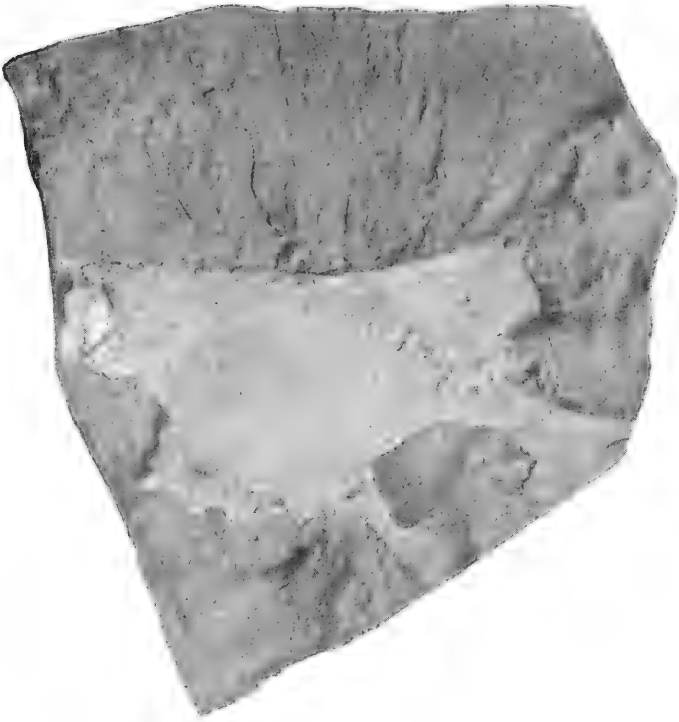
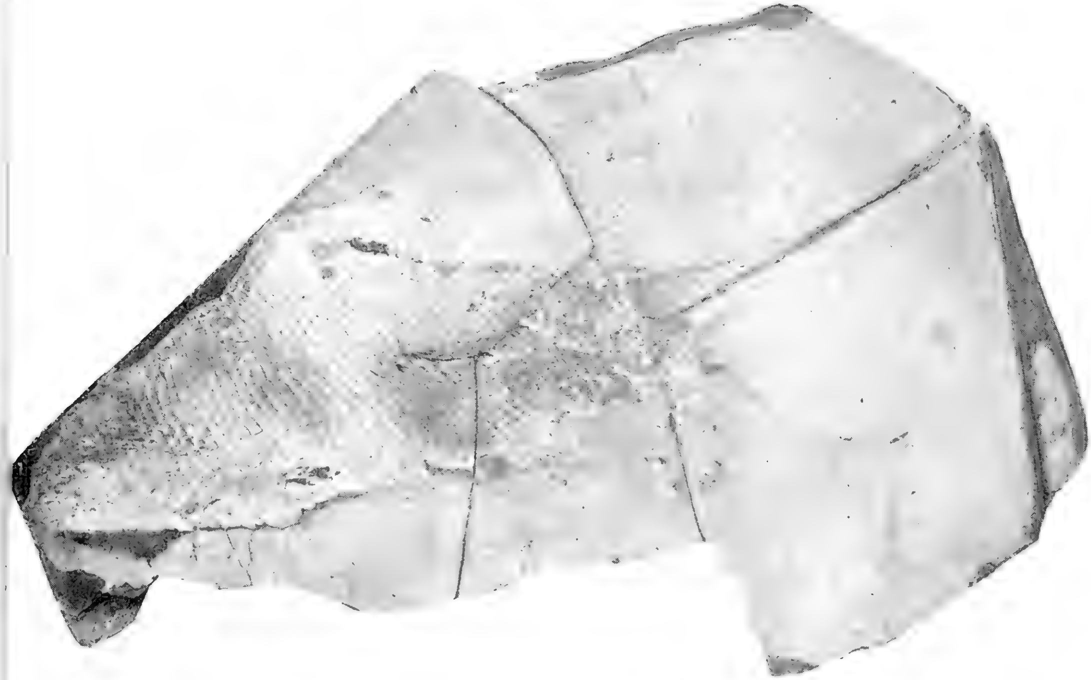


2

CARUICHTHYS ORNATUS, Broom.
ATHERSTONIA CAIRNCROSSI, Broom.



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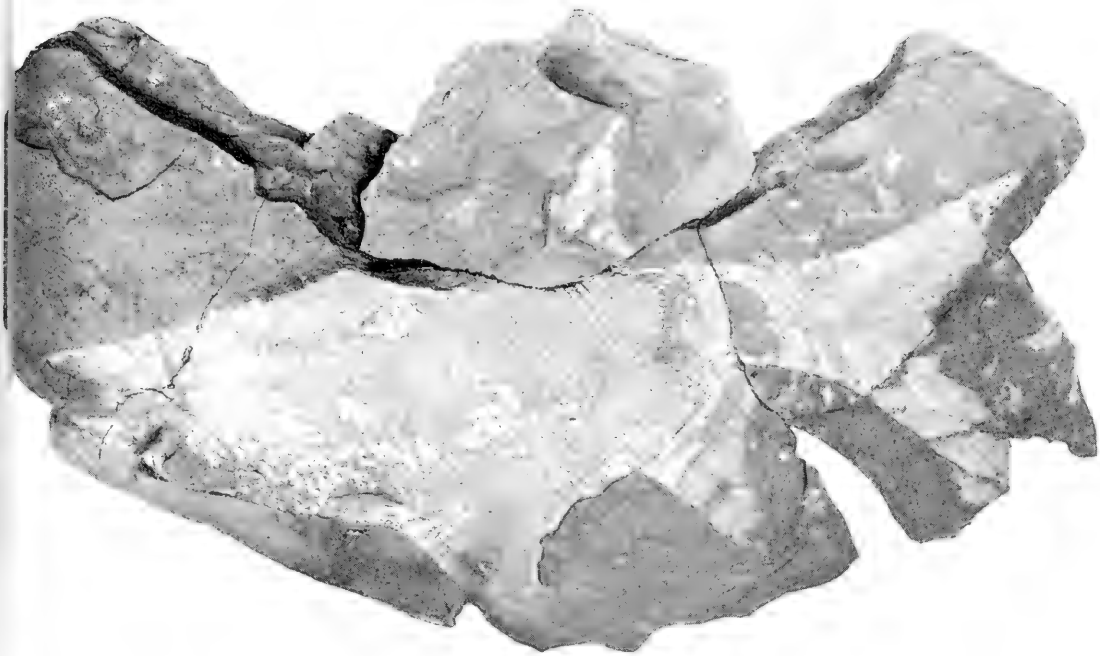

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PALÆONISCUS CAPENSIS, Broom.
ELONICHTHYS WHAITSI, Broom.

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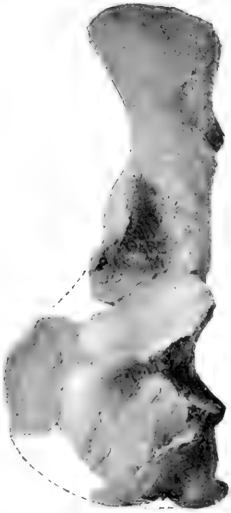

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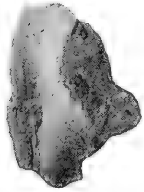

6

PAREIASUCHUS PÉRINGUEYI, Broom & Haughton.

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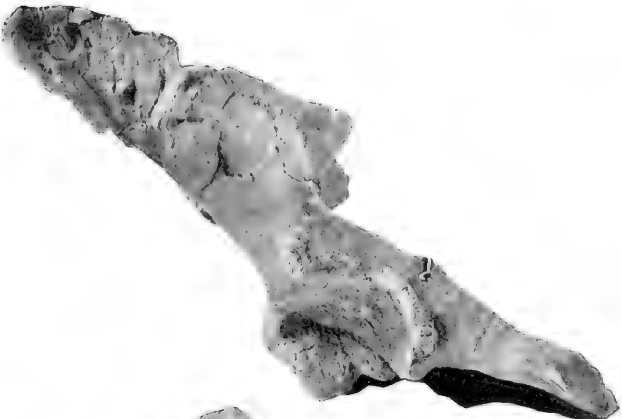

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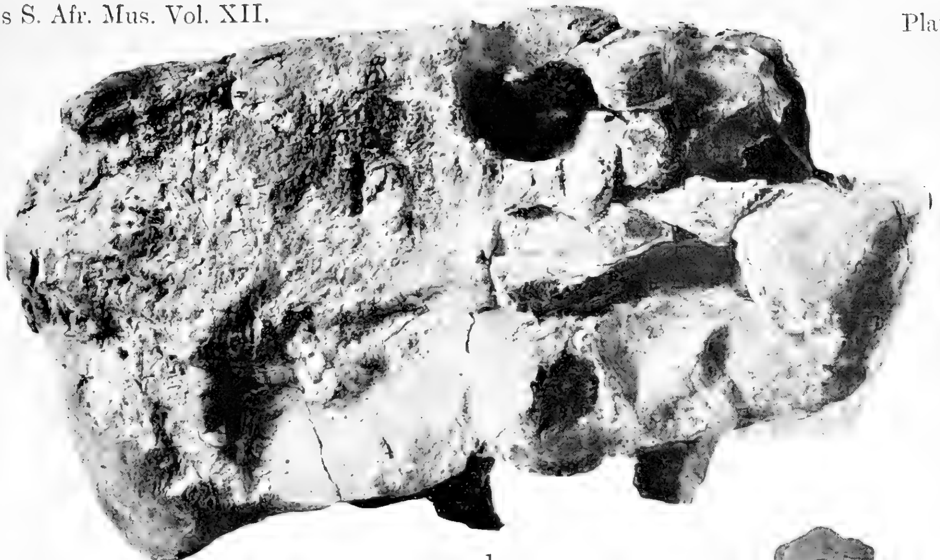
PAREIASUCHUS PÉRINGUEYI, BROOM & HAUGHTON.
PROPAPPUS PARVUS, HAUGHTON.

PARELASUCHUS PÉRINGUEYI, Broom & Haughton.



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SCYMNOGNATHUS TIGRICEPS, Broom & Haughton.
SCYLACOPS CAPENSIS, Broom.

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DICYNODON ALTICEPS, Broom & Haughton.

DICYNODON TESTUDIROSTRIS, Broom & Haughton.

10.—*Investigations in South African Fossil Reptiles and Amphibia* (Parts 1–4).—By S. H. Haughton, B.A., F.G.S., *Assistant Director.*

1. *On a New Species of Trematosaurus* (*T. sobeyi*).

(Plates VIII., IX.)

The remarkably fine skull upon which the following observations are based was recently presented to the South African Museum by Messrs. Sobey Bros. through the medium of the Queenstown Municipal Authorities. It was found in the building-stone quarries belonging to these gentlemen, and when received at the Museum the top had been wholly freed from matrix. The palate was embedded in a slab of hard, homogeneous calcified sandstone, and the occipital condyle had been broken off, and has not been recovered. I have cleaned one side of the palate to show the sutures between the bones. In doing so the skull fractured across in three places, and thereby enabled some knowledge of the relations of the median bones to be obtained. The skull obviously belongs to a hitherto undescribed species, and I have pleasure in naming it after the donors.

The skull is large, triangular in outline, the snout gradually tapering. The nostrils are oval in shape, approximate, some distance behind point of snout. Orbits are small, placed midway between front and back of skull. The snout is rugose. The sculpturing of the cranial bones is of the usual Labyrinthodont type, pitted at the centre with radiating grooves at the periphery. The suprasquamosal, postfrontal, and postorbital are relatively less grooved and more pitted than the other bones.

The chief measurements of the skull are as follows:—

Greatest length along border	517	mm.
Greatest breadth	305	,,
Tip of snout to occipital plate	411	,,
Snout to plane of front of nostril	65	,,

Length of nostril	27 mm.
Internasal breadth	31 ,,
Preorbital length	217 ,,
Length of orbit	24·5 ,,
Interorbital width	90 ,,
Length of frontal	160 ,,
Length of nasal	149 ,,
Length of parietal	114 ,,

The premaxillae are divided from one another by a median suture, and posteriorly they are separated for half their length by the nasals. They form most of the snout, and the whole of the anterior borders of the nostrils. Midway between the front of the nasals and the snout the premaxillary suture is pierced by a small fenestra, which apparently contains no bone corresponding to the internasal described by Watson in *Micropholis stowi*. A fracture obliquely across the nostrils shows the premaxilla lying outside the septomaxilla and below and within the maxilla, articulating with the latter by a complex suture.

The maxilla extends for a length of 308 mm. from the premaxilla back to the quadrato-jugal. It is a narrow bone, tapering out posteriorly from a maximum height of 27 mm. just behind the septomaxilla.

The septomaxilla appears on the surface of the face for a distance of 11 mm. behind the nostril, and forms almost the whole of the posterior border of the nostril, the nasal just entering into the border on the superior edge. The septomaxilla meets the maxilla and the nasal, but not the lachrymal. Its cheek portion has a triangular form. It forms the floor of the nostril, and extends downwards inside the maxilla and premaxilla.

The nasal is a large bone articulating with the premaxilla, septomaxilla, maxilla, lachrymal, prefrontal, frontal, and interfrontal. Anteriorly and between the nostrils it is comparatively narrow; in the middle it widens out to form the whole of the upper surface, while posteriorly it tapers, being separated from its neighbour by the interfrontal and frontals.

The interfrontal is a median rhombic bone, 50 mm. long and 9 mm. broad, articulating for half its length with the nasals and for half with the frontals. Broom has recently described this bone in *Eryops*, and it is known to occur in a number of small Stegocephalians. Unfortunately the type of *Trematosaurus kannemeyeri* does not show this region. If an interfrontal did occur in that

species, however, it must have been considerably further in advance of the orbits than in the species under consideration.

The lachrymal is a long bone forming the inferior anterior quadrant of the orbital border, and passing forward to within 33 mm. of the nostril. Anteriorly it lies between the nasal and the maxilla, and posteriorly meets the jugal below the orbit. Superiorly it has a long articulation with the prefrontal.

The prefrontal is a broader and stouter bone forming the superior anterior quadrant of the orbital border. It meets the lachrymal, nasal, frontal, and postfrontal.

The frontal is a comparatively narrow, elongate bone, 160 mm. in its greatest length, completely shut out from the orbit by the junction of the prefrontal and postfrontal. Together the frontals form one-half of the interorbital width. Posteriorly they meet the parietal, being separated from each other for the last 35 mm. by that bone.

The postfrontal is larger than the prefrontal. It forms at the most but 12 mm. of the orbital border. It articulates with the prefrontal, frontal, parietal, suprasquamosal, and postorbital.

The postorbital is considerably larger than the postfrontal, forming 15 mm. of the orbital border, and extending back for 130 mm., being 40 mm. broad in its widest part. It articulates with the jugal for most of its length, with the squamosal, suprasquamosal, and postfrontal. It differs from the corresponding bone in *T. kannemeyeri* in that there is no constriction behind the orbit. Indeed, from the orbital border the bone rapidly widens.

The jugal is a large bone, forming part of the posterior border of the orbit and extending from the lachrymal backwards for a length of about 200 mm. It has a short vertical articulation with the lachrymal, a long junction with the maxilla, and posteriorly lies between the quadrato-jugal and the squamosal. On its upper border it meets the postfrontal.

The parietal is smaller than the frontal, and lies in a marked depression of the cranial surface. Its greatest length is 115 mm., and the circular pineal foramen lies between the bones 82 mm. behind the anterior point of the elements.

The suprasquamosal is a large bone 100 mm. long and 55 mm. broad, practically rectangular in shape. It articulates with the parietal, postfrontal, postorbital, squamosal, tabulare, and postparietal.

The postparietal is placed behind the parietal, forming part of the upper cranial surface and being bent at right angles to form the

central half of the upper part of the occipital plate. Its lower occipital border articulates apparently wholly with the exoccipital.

The tabulare forms the outer upper angle of the occiput. It appears on the upper cranial surface, articulating with the squamosal, suprasquamosal, and postparietal. It forms most of the upper border of the lateral occipital foramen, and part of the outer and lower border; but owing to fracturing and splintering of the bones its articulation with the paroccipital is difficult to ascertain exactly.

The squamosal is larger than the suprasquamosal. Above it articulates with the postorbital, suprasquamosal, and tabulare, and below with the jugal and quadrato-jugal.

The quadrato-jugal is a large bone forming the posterior angle of the skull. Anteriorly it passes forward to the maxilla, articulating with the jugal and squamosal. It is bent to form part of the back

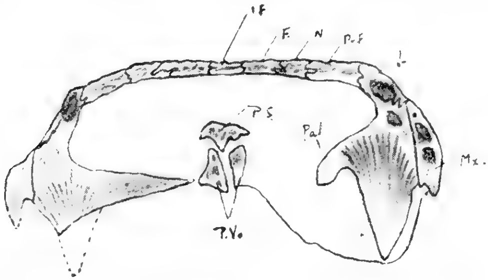


Fig. 6.—*Trematosaurus sobeyi*, Haughton. Diagram of section of skull just anterior to the orbits. × ½.

surface of the angle, and overlaps the quadrate, which is also overlapped on its inner border by the squamosal and pterygoid.

Both the premaxilla and maxilla bear teeth of more or less uniform size. Near the front of the snout the premaxilla carries two slightly larger teeth, of which the first is 15 mm. long and recurved. There are 10 other smaller teeth on the premaxilla. The maxillary teeth are about 50 in number, borne in a row along the whole length of the bone, the final teeth being slightly the smallest. The average length of the larger teeth is about 10 mm., and they are arranged fairly evenly along the bone, 10 teeth below the orbit occupying a space of 26 mm.

The palatal view of the skull shows some interesting features. The premaxilla extends back for a distance of about 50 mm. from the front of the palate, and articulates behind with the prevomer.

The prevomer is a large bone, forming the inner and anterior walls of the posterior nares, and most of the front of the palate. It articu-

lates with the premaxilla in front, and with the palatine and parasphenoid behind. Arising from a depression in front of the posterior nares is a large tusk, with a basal diameter of 20 mm. and a height of about 33 mm.—the largest tooth in the skull. Lying along the wall of the posterior opening is a series of 8 smaller teeth, elliptical in section, with the long axis of the ellipse lying at right angles to the mid-plane of the palate. These teeth are separated from each other by elliptical pits, now filled with calcite crystals. There is no evidence of minute prevomerine teeth.

The palatine forms the hinder border of the posterior nares, and articulates with the prevomer, the maxilla, and the transpalatine. It carries three large tusks in an antero-posterior line, of which the first is the largest.

The transpalatine lies along the inside of the maxilla, articulating with the pterygoid behind and the palatine in front. It carries a row of teeth of varying size.

The pterygoid is a large bone, diverging in three directions from a central plate at the back. Interiorly it is loosely articulated with the flat portion of the median bone which is presumably the parasphenoid; posteriorly it passes upwards and backwards partially to wrap round the quadrate, and meets the squamosal; anteriorly and externally it meets the transpalatine in a long articulation. Behind this last articulation it is covered with a number of minute pointed teeth almost to the plane of the back of the large vacuity. It also has a short articulation externally with the maxilla.

The parasphenoid has the form of a large median thin plate at the back of the palate, which passes forward to the prevomers. These pass backwards on both sides of the lower part of the bone for some distance as thin bones with long articulating inner surfaces. A section across the skull between the orbits and the nostrils shows the parasphenoid lying above the prevomers and sending down a small process between them. A section across the parasphenoid at the front of the parietals shows a vertically elongated oval with two wing-like projections superiorly—not passing to the bones of the cranium. Between these projections and the mass of the bone I can detect no sutures. Posteriorly the parasphenoid plate sends up a short process to meet the downward projection of the exoccipital.

The occiput is broken away in part, and neither the basisphenoid nor basioccipital can be detected. The exoccipital seems to have played the most prominent part in the formation of the occipital condyle.

2. *On a New Dinocephalian from the Gouph.*

(Plate X.)

The specimen on which the following description of a new genus and species is based is No. 2678 in the South African Museum collection, and was collected by the Rev. J. H. Whaits near Vivier Siding, 30 miles south-west of Beaufort West, from beds in the *Pareiasaurus* zone. It consists of the almost perfect skull which has undergone considerable weathering. The general shape and features of the skull differ sufficiently from the other Dinocephalian genera to warrant its inclusion in a new genus and species, and for it I propose the name *Struthiocephalus whaitsi*, g. et sp. nov.

The chief generic characters are as follows: Skull large; snout relatively long and slender; frontal and temporal regions not so much elevated above snout as in *Tapinocephalus*; eyes look forward and outward; heavy overhanging supraorbital crests; temporal fossae larger than orbits, elliptical in shape with shorter axis parallel to axis of skull; teeth weak, undifferentiated, and few in number.

The following table gives some of the chief measurements :—

Greatest length	580	mm.
Greatest breadth	355	,,
Greatest height	230	,,
Length of snout to back of internal nares	200	,,
Breadth of snout at back of internal nares	230	,,
Length of orbit	95	,,
Height of orbit	60	,,
Length of temporal fossa	80	,,
Height of temporal fossa	148	,,
Interorbital width at front of orbit	180	,,
Interorbital width at back of orbit	295	,,
Intertemporal width	130	,,
Basal length	515	,,

The snout is slightly distorted from its true position, the angle of distortion being about 15° to the right. The premaxilla bears three

teeth, which are small and of the usual type. On the maxilla two teeth can be discerned.

The nostrils are large, and placed well forward. The nasals are long bones, and along their junction below the well-marked frontal boss is a fairly deep median groove 56 mm. long.

It is difficult to be absolutely certain of the sutures of the top of the skull on account of the peculiar weathering of the surface, but their probable positions can be assigned.

The prefrontal and lachrymal are both large bones, coming well forward from the orbital border on to the cheek. The prefrontal forms most of the anterior border of the orbit.

The frontals form the upper border of the orbit, giving rise to the very pronounced supraorbital crest. Near their anterior margin, and just above the groove in the nasals, is a large median boss, the presence or absence of which may probably be taken as a specific character in this genus. The postfrontals, if present, are indistinguishable.

The pineal foramen is large and situated just behind the postorbital bar. It is entirely surrounded by the parietals.

The eye is large, looking forwards and outwards. The temporal fossa is larger than the eye, higher than long, and looks outwards, upwards, and slightly backwards. It is almost wholly bounded by the postorbital and the squamosal, only a portion of its superior border being formed by the parietal.

The postorbital bar is very massive, being strongest at the junction with the jugal. The squamosal has a broad descending portion which passes forward, articulating with the jugal and pushing the quadrate forward to the level of the middle of the orbit.

The quadrate has a large articular surface for the lower jaw. Posteriorly it forms a flat, plate-like bone which articulates with the squamosal and the paroccipital. The quadrato-jugal is well defined, but small. Its upper border is clasped by the jugal, its lower border rests on the squamosal, while internally it articulates with the quadrate. Apparently it forms no part of the articular surface for the lower jaw.

The interparietal is 70 mm. high, and narrows rapidly below. It articulates laterally with the tabulare, and inferiorly with the bone which may be the supraoccipital, although—on account of the imperfection of the specimen—no suture can be seen between that bone and the basioccipital. The element in the lateral part of the occiput, which was mentioned in the description of *Scymnognathus tigriceps* as occurring in Dinocephalians, is here well seen, and

is the tabulare. It is a large membrane bone lying behind the squamosal almost for the whole length of the posterior border of the temporal fossa, being thickest at its lowest end. It forms the larger part of the occipital plate lying above the condyle.

The squamosal forms but little of the occipital plate, the par-occipital extending almost to the border. In other Dinocephalians the squamosal enters largely into the composition of the occipital aspect.

The condyle is large, single and rounded.

The palatal view is similar to that of *Tapinocephalus*. The basi-occipital is a large bone. The pterygoids are separated by a long median groove. The stapes articulates with the basioccipital and the pterygoid.

3. *On Two New Therocephalians from the Gouph.*

Trochosaurus intermedius, g. et sp. nov.

This new genus and species is founded upon a weathered and crushed skull and lower jaw found on the farm Abraham's Kraal, in the Prince Albert Division, in beds belonging to the *Pareiasaurus* zone. The parietal region is incomplete and the occipital plate is missing, while the zygomatic arches are very weathered. Fracturing of the skull has displayed the structure of the palate.

The right premaxilla bears five incisors, of which only the fifth retains the crown. They are subequal in size, and together occupy a space of 48 mm. at the margin of the bone. The 5th, which is slightly smaller than the others, has a diameter of 6·5 mm. at the gums and is 15 mm. long, curving slightly backwards. The incisors were simple, pointed teeth, apparently without serrations or longitudinal grooves. There is a diastema of 7 mm. between the fifth incisor and the first canine. There are two canines, both of which were large and functional, the second being slightly larger than the first. In section the teeth were apparently oval. A section across the snout shows a smaller replacing tooth lying internal to the first canine and parallel to it. Close behind the second canine came the small molars, of which there do not seem to have been more than four.

The nostrils are large and are placed almost terminally. Almost the whole of the lower border is formed by the large septomaxillary, which sends off a turbinal process partially dividing the nares into two portions. Between the septomaxilla and maxilla is the usual outer foramen.

The nasal is fairly broad and comparatively short.

The interorbital width is almost twice that of the intertemporal region. The frontals are large, forming 9 mm. of the upper border of the orbit.

The limits of the prefrontal and lachrymal are not wholly determinable, but the prefrontal was certainly large.

There is a distinct though small postfrontal, which forms no part

of the border of the temporal opening. The pineal foramen is large, 18 mm. behind the postorbital bar, and entirely surrounded by the parietals.

The postorbital is rather weak, and forms the whole of the anterior and more than half the upper border of the temporal fossa.

The palate is typically Therocephalian in structure. The prevomers are narrow bones passing some distance backward behind the internal nares, and forming the inner border of those openings. Their sutures with the pterygoid are indeterminable.

The palatine is a plate-like bone forming a small part of the posterior border of the internal nares, and having a long articulation with the maxilla.

The pterygoid is large. The transpalatine is large, and articulates with the pterygoid, maxilla, and palatine. Between it and the pterygoid there is a very well-defined foramen.

The symphysis of the lower jaw is weak. The dentary is a strong bone, forming about two-thirds of the jaw. It possesses a pronounced mentum. The splenial extends back as far as the plane of the front of the orbit, lying along the inside of the dentary. It is a thin bone. The coronoid is small. The angular lies posterior to the dentary, wedged in between that bone and the splenial. Between it and the dentary is a small foramen. The surangular is large, but is more than half-hidden from view by the angular.

The chief measurements of the skull are:—

Greatest length	230	mm.
Distance from snout to front of orbit	115	,,
Diameter of orbit	42	,,
Interorbital width	46	,,
Intertemporal width	28	,,

In the possession of two large canines and five incisors this form resembles *Lycosuchus* and *Trochosuchus*. It lies nearest to the former genus, being distinguished from it by the shallow incisor region of the upper jaw, by the much deeper dentary—characters in which it agrees with *Trochosuchus*—and by the greater width of the intertemporal region. From *Trochosuchus* it is distinguished by the fact that the two canines are approximately equal in size, whereas in the older genus the first canine is of the size of the incisors, and the second canine is considerably larger. This form, therefore, seems to stand in an intermediate position between *Lycosuchus* and *Trochosuchus*.

The type is in the South African Museum (Cat. No. 2756).

TITANOSUCHUS DUBIUS, sp. nov.

The portion of mandible on which this species is founded was obtained from the farm Abraham's Kraal in the Prince Albert Division. It is the right ramus, showing four incisors, one canine, and eleven small molars. It differs from *T. cloetei* in having a more massive symphysis, in being even squarer in the front of the jaw, in the much larger canine and smaller molars—differences which appear to warrant the erection of a new species.

A table showing the teeth measurements in the three known species of *Titanosuchus* will emphasize their differences:—

	T. ferox.	*T. cloetei.*	*T. dubius.*
First incisor	Imperfect	21 × 14	Imperfect
Interval between *i*.1 and *i*.2	10	10	9
Second incisor	21 × 15	18 × 13·5	19 × 14·5
Interval between *i*.2 and *i*.3	10	11	4
Third incisor..................	20 × 12	20 × 14	20 × 15
Interval between *i*.3 and *i*.4	18	8	6
Fourth incisor	23 × 17	18 × 14	16·5 × 13
Interval between *i*.4 and *c*	?	9	5
Canine	50 × 35	30 × 26	47 × 20
Four molars occupy.........		40	30
Eleven molars occupy......			107

[All these measurements are in millimetres.]

It will be seen that the incisors are set much closer together in this new form, although on the whole their size does not differ appreciably from those of *T. cloetei.* The canine is narrower and longer. In fact, whereas in *T. cloetei* it approximates in section to a circle, in the new species it is almost oblong, with one side more than twice the length of the other.

The molars are small and circular in section. A line drawn along the inner side of the molars just touches the canine, and is also tangential to the inner surface of the 4th incisor.

If a line be drawn across the front of the jaw at right angles to the symphysis, the back of the canine lies 76 mm. from it, and the back of the 4th molar 111 mm.; whereas in *T. cloetei* the figures for the same measurements are 67 mm. and 116 mm. respectively.

4. *On Some New Anomodonts.*

(Plate XI.)

Dicynodon mustonis, sp. n.

This species is founded on an almost perfect small skull and lower jaw collected by me in 1913 at Dunedin, Beaufort West. The only parts lacking are the posterior extension of the right squamosal, the right postorbital arch, and the left articular end of the lower jaw. Most of the matrix has been cleared away, and the sutures between the bones are for the most part beautifully displayed.

In general shape the specimen approximates most nearly to *Diictodon Kolbei*, although it is but half the size; but it is generically distinct in that the small preparietal does not entirely surround the pineal foramen, but forms only its anterior border. The anterior half is roughly of the shape of an equilateral triangle, the posterior half almost square. The skull is flat and of graceful proportions. The antorbital portion is short, the orbits large and directed mostly upwards, lying wholly in the anterior half of the skull.

The premaxillary is large, the internasal process passing back almost to the frontals. The maxilla is comparatively small, although the caniniform process descends considerably below the level of the beak and zygomatic arch. The nostril is large, and is overhung by a prominent rugose nasal boss. There appears to be a small septomaxillary at the back of the nostril, which does not, however, form any part of the cheek.

The anterior frontal region is flat, but posteriorly the region between the postorbital arches and extending between the postorbitals is markedly concave. The frontals are long, passing back almost to the pineal foramen, each separating the two anterior processes of the parietal. There is a marked supraorbital ridge which passes forward into the prefrontal, the ridge becoming less pronounced towards the lachrymal.

The postfrontals are large, elongate, triangular bones extending back between the parietals and postorbitals to the level of the pineal foramen. The postorbital arch is comparatively slender, and in its

outer half the postorbital is supported by the jugal, which also extends along two-thirds of the inner side of the zygoma.

The pineal foramen is situated some distance behind the postorbital arch. It is 6 mm. long, and its anterior border is formed by the narrow, elongate preparietal. The parietal sends a process forward between the frontal and preparietal to the level of the postorbital arch, and extends back for about half the length of the temporal fossa. The postorbital forms almost the whole of the upper border of the fossa.

The squamosal is large, and has a large boss on its expanded portion. It extends back for some considerable distance behind the occipital plate, which slopes well forward in its upper half.

The interparietal comes well on the top of the skull and is greatly developed laterally. The quadrato-jugal is large, and the quadrate well displayed.

The lower jaw has a very deep mentum, the lowest point coming a little behind the plane of the caniniform process, *i.e.* just below the front of the orbit.

The following are the chief measurements of the skull :—

Greatest length	150 mm.
Maximum width	112 ,,
Maximum width of parietal region	24 ,,
Maximum width of frontal region	19 ,,
Maximum width of nasal overhang	29 ,,
Minimum width across pterygoids	15 ,,
Length of pineal foramen	6 ,,
Width of pineal foramen	3 ,,
Distance of pineal foramen behind postorbital bar	10 ,,
Basal length	126 ,,
Width between inside of caniniform processes	24 ,,
Maximum depth of lower jaw	33 ,,

I have much pleasure in naming this species after Mr. J. A. Musto, the former owner of Dunedin, from which place so many interesting and varied types have been obtained.

Type. Female skull. (S.A.M. Cat. No. 2674.)

Dicynodon breviceps, sp. n.

This new species is founded upon a somewhat imperfect and weathered skull and lower jaw (S.A.M. Cat. No. 2366) from the

farm Voetpad in the Division of Murraysburg, Cape. The chief features lie in the shortness of the skull compared with the width, the great height, the size and shape of the orbit and of the temporal fossa. Although all the features are not visible, enough is seen to show that the skull differs considerably from any hitherto-described species.

The greatest length is 170 mm., while the maximum width across the squamosals was probably 180 mm. The front of the snout is weathered away, but was nearly vertical and very high, the nasal region being very convex and the nostrils almost at the front of the skull. The preorbital portion is short.

The premaxilla is small. The nasals are narrowed anteriorly—the nostrils being close together. There is a well-marked septo-maxillary forming the posterior wall of the nostril and a small portion of the cheek-surface.

The eyes are large, rhomboidal in shape, looking mainly outwards. The frontal region widens considerably posteriorly, the minimum width—25 mm.—being well towards the front of the orbit. The frontal region is flat and there is a slight supraorbital ridge.

The postorbital portion is not complete. The bar was apparently comparatively slender, while the postorbital extended back to form the whole of the upper border and part of the posterior border of the temporal fossa. The parietal region has a maximum width of 32 mm., and is very short.

There is a long and slender preparietal, supported along the posterior part by the parietals, and in its anterior half by the frontals. It extends only so far back as just to touch the anterior border of the pineal foramen, which lies 10 mm. behind the postorbital bar, and is 11 mm. long and 6 mm. wide.

The postfrontal is well seen on the right side. It is well developed, very narrow in its posterior half and articulates with the frontal, parietal, and postorbital.

The squamosal has a very long downward process supporting a large, plate-like quadrato-jugal. Anteriorly it is overlapped by the jugal, which is a very stout bone and extends half-way along the lower border of the temporal opening.

The palate is short and wide, the width between the bases of the caniniform processes being about 40 mm. There is no trace of tusks.

The lower jaw is displaced from its true position. Its total length is probably 110 mm., and the depth at the symphysis 40 mm. The front of the jaw is bluntly rounded and strong, and there is no

upwardly projecting beak and no pronounced mentum descending below the level of the bottom of the jaw.

LYSTROSAURUS OVICEPS, sp. n.

There is in the collection of the South African Museum the skull and lower jaw (No. 641) of a small specimen of *Lystrosaurus* which can be correlated with no hitherto-described species, and which is therefore described here as a new species. It is said to have come from the "Tarka River, Cradock District," and is in a fine-grained grey sandstone.

The greatest length of the skull when viewed from above is 163 mm. The greatest breadth is 129 mm. The minimum interorbital width is 46 mm. and the minimum intertemporal width 25 mm. The orbit is elliptical with the long axis parallel to the nasal plane; its length is 36 mm., its height 33 mm.

The snout is slightly convex with a median ridge, which is very prominent in the middle of the premaxilla, but dies away at the extremities of that bone. The premaxilla passes up as a narrow prolongation between the nasals. Its greatest length is 76 mm., and its width at the mouth—measured round the bone—is 56 mm.

The maxilla is a rectangular bone, with a suborbital prolongation supporting the jugal. The tusks are circular in section, and directed slightly inwards. Their diameter at the base is 9 mm.; length probably 25 mm. The distance between the inner sides of their bases is 46 mm.

The septomaxillary forms a distinct part of the cheek, besides being the posterior wall of the nostril.

The fronto-parietal plane makes an angle of about 120° with the general plane of the snout, but the change of slope is not very abrupt owing to the convexity of the snout. The transverse ridge across the nasals is not nearly so pronounced as in the other species. The prefrontal forms the superior anterior quadrant of the orbital border, but the supraorbital boss is very slight.

The frontal forms the remainder of the upper border of the orbit, and at the frontal junction is a slight median ridge. In each bone is a slight but well-marked central boss from which lines of sculpture radiate. These bosses are further from the median ridge than the corresponding protuberances in *L. declivis*.

The preparietal is large, circular, excavated, concave, and has a maximum length of 19 mm. It forms the border of the anterior third of the pineal foramen, which is of the keyhole shape common

to species of *Lystrosaurus* and 8 mm. in length. The boundaries of the postfrontal are not seen, but it must have been a small bone.

The parietal region is wide and flat. The parietals are small, the postorbitals forming the whole of the upper borders of the temporal fossae. These are transversely oblong in shape, 39 mm. broad and 25 mm. long.

The squamosal has a pronounced ear-shaped expanded portion at the outer border of the temporal opening, the projection being more prominent than in *L. latirostris.* The zygomatic portion of the squamosal is thin and flat. There is a large quadrato-jugal which apparently forms part of the articular surface for the lower jaw.

The development of the posterior part of the palatal surface shows one or two interesting features. The pterygoid is of the usual *Lystrosaurus* type, having a long articulation with the basisphenoid, and an outward and backward process which extends to the stapes. The basisphenoid is bent at right angles to the plane of the palate, and is pierced by the two carotid foramina.

Hitherto in *Lystrosaurus* the whole of the lateral bone extending from the condyle to the squamosal has been called exoccipital; but this specimen shows that the so-called "exoccipital" is in reality made up of two bones, the true exoccipital and the paroccipital (opisthotic). The exoccipital is a small bone closely united to the paroccipital, forming part of the condyle and of the wall of the foramen magnum. The paroccipital is a large bone stretching from the squamosal to the small exoccipital and having an inner downward projection articulating with the basioccipital. It is pierced near the exoccipital suture by the opening for the IXth–XIIth nerves.

The depth of the lower jaw at the symphysis is 34 mm. The lowest point of the mentum is directly below the point of the tusk.

This new species comes nearest to *Lystrosaurus latirostris*, from which it differs, however, in the convexity of the snout, in the angle between the fronto-parietal and premaxillary planes, in the ratio between the interorbital and intertemporal widths, in the shape of the orbit, and in other minor features. When viewed posteriorly the skull is seen to differ from both *L. declivis* and *L. latirostris.* The parietal region is not grooved so deeply as in the type species, and the zygomatic portion of the squamosal is much wider in *L. latirostris.*

EXPLANATION OF PLATES.

PLATE VIII.

1. Trematosaurus sobeyi, sp. n.

FIG.

1. Top view of skull. × $\frac{1}{3}$ nearly.
2. Diagram showing arrangement of bones of top of skull. × $\frac{1}{3}$ nearly.

PLATE IX.

2. Trematosaurus sobeyi, sp. n.

1. Palatal view of skull. × $\frac{1}{3}$ nearly.
2. Diagram showing arrangement of bones and teeth of palate. × $\frac{1}{3}$ nearly.

PLATE X.

Struthiocephalus whaitsi, g. et sp. n.

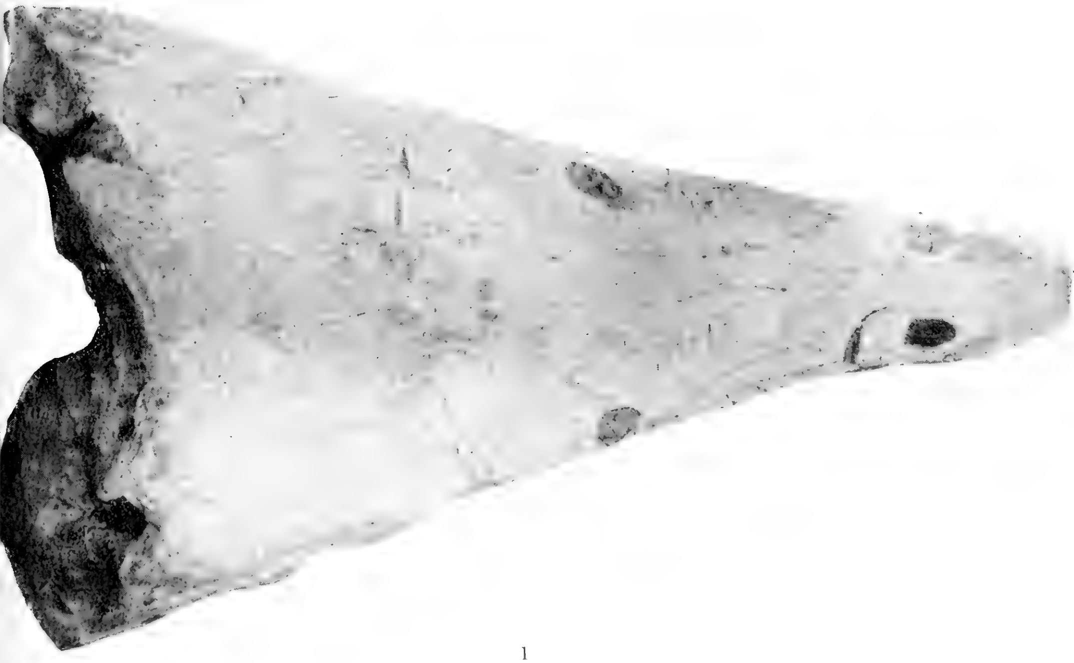
1. Side view of skull. × $\frac{1}{5}$.
2. Palatal view of skull. × $\frac{1}{5}$.
3. Top view of skull. × $\frac{1}{5}$.

PLATE XI.

1. Top view of skull of *Dicynodon mustonis*, sp. n. × $\frac{1}{2}$.
2. Diagram showing arrangement of bones round pineal foramen in *Dicynodon breviceps*, sp. n. × 1.
3. Top view of skull of *Lystrosaurus oviceps*, sp. n. × $\frac{7}{16}$.
4. Side view of skull of *Lystrosaurus oviceps*, sp. n. × $\frac{1}{2}$.

EXPLANATION OF LETTERING.

F., Frontal; I.F., Interfrontal; J., Jugal; L., Lachrymal; Mx., Maxilla; N., Nasal; P., Parietal; Pal., Palatine; Pa.S., Parasphenoid; P.for., Pineal foramen; Pmx., Premaxilla; Po.F., Postfrontal; Po.O., Postorbital; Po.P., Postparietal; Pp., Preparietal; Pr.F., Prefrontal; Pt., Pterygoid; P.Vo., Prevomer; Q., Quadrate; Q.J., Quadratojugal; Smx., Septomaxilla; Sq., Squamosal; S.Sq., Suprasquamosal; Tab., Tabulare; T.P., Transpalatine.



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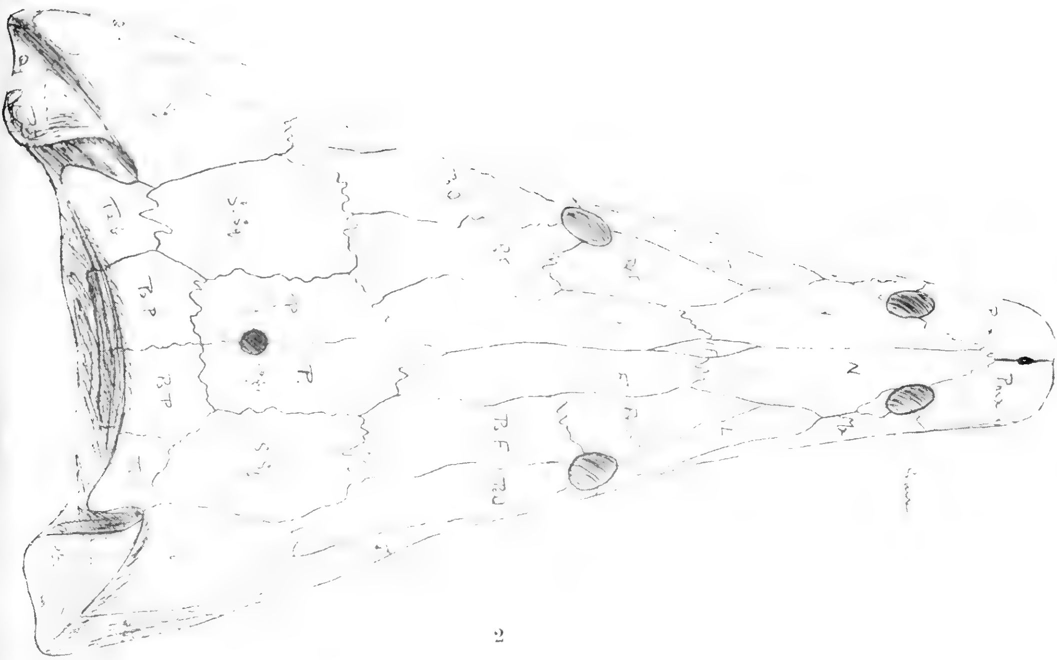
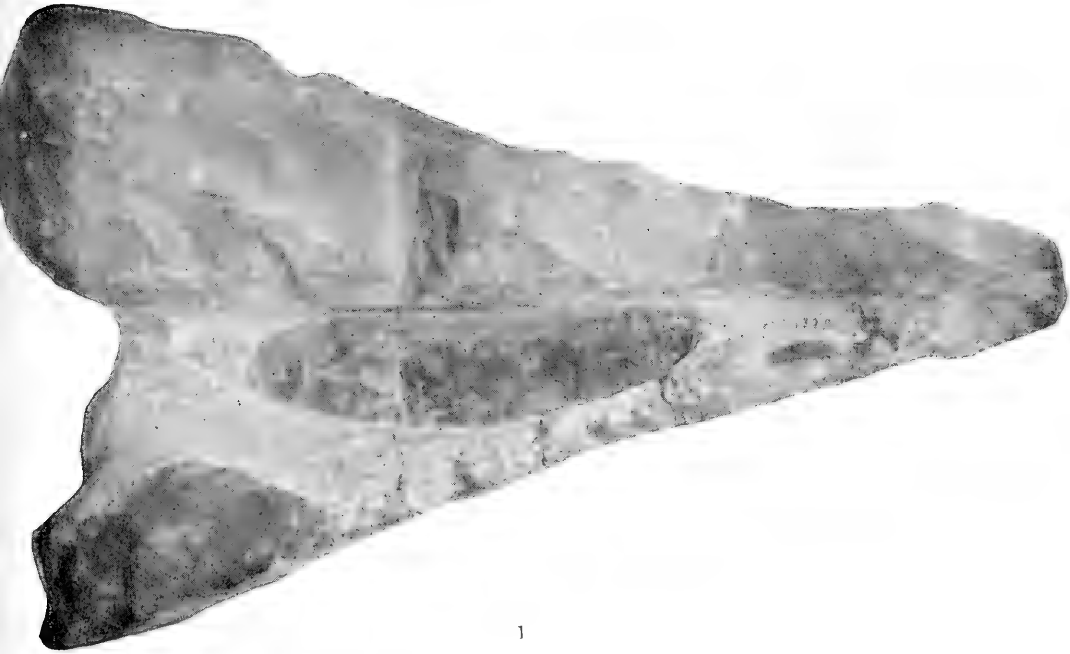


2

TREMATOSAURUS SOBEYI, Haughton. × $\frac{1}{3}$ nearly.



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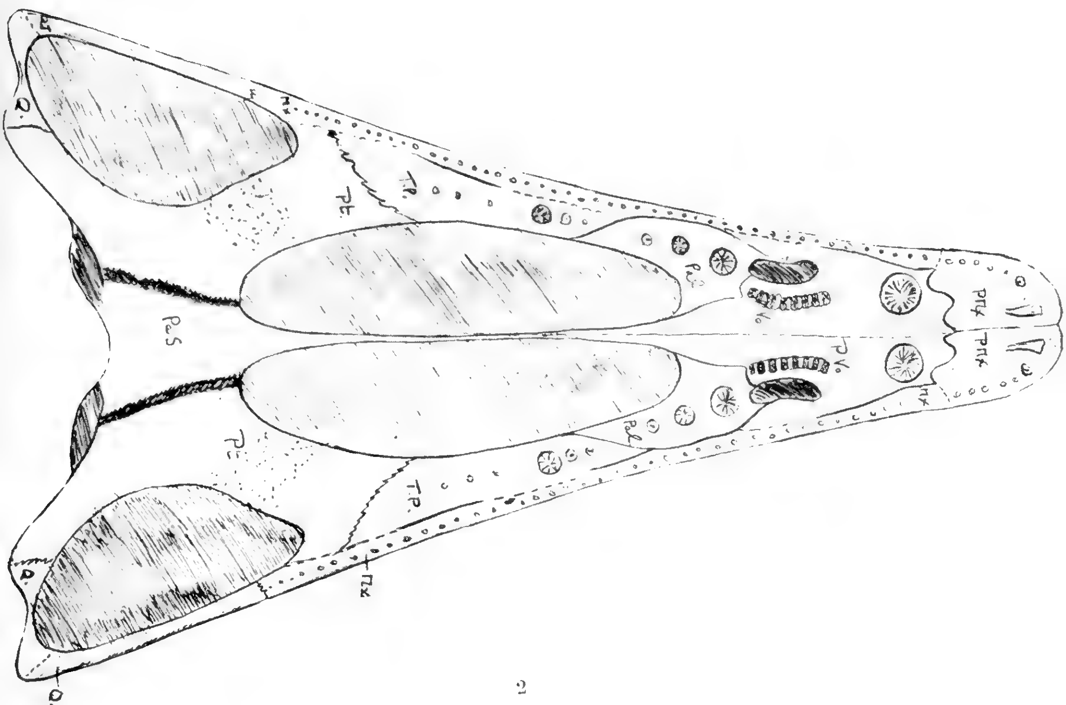

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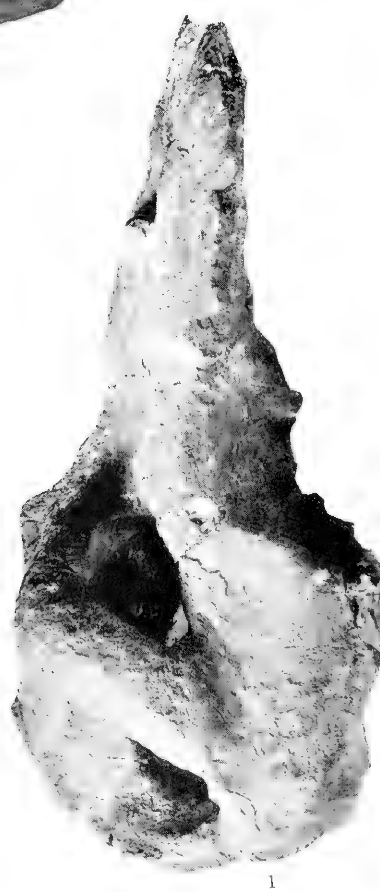
TREMATOSAURUS SOBEYI, HAUGHTON. × $\frac{1}{3}$ NEARLY.

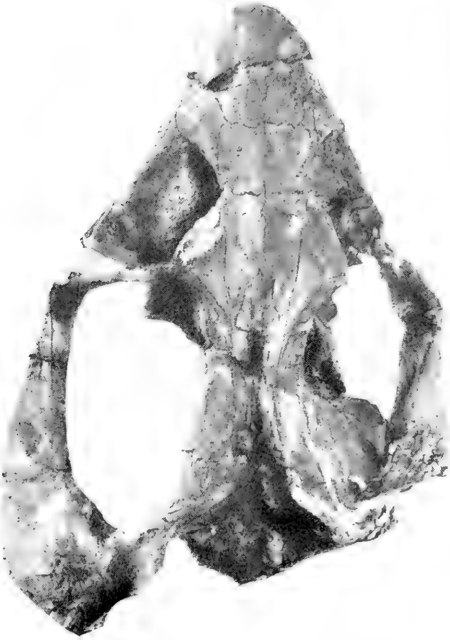
3

2



1

STRUTHIOCEPHALUS WHAITSI, Haughton. × $\frac{1}{5}$.



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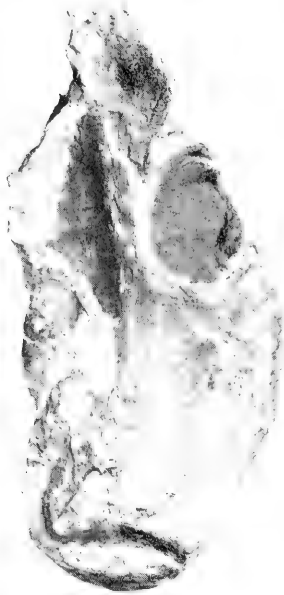


4

1. *DICYNODON MUSTONIS*, Haughton. × ½.
2. *DICYNODON BREVICEPS*, Haughton. × 1.

3, 4. *LYSTROSAURUS OVICEPS*, Haughton. × ½.

11.—*Investigations in South African Fossil Reptilia and Amphibia* (Parts 5–9).—By S. H. Haughton, B.A., F.G.S., *Assistant Director.*

5. *On the Genus* Rhinesuchus, *Broom, with Notes on the described Species.*

The genus *Rhinesuchus* was first described by Broom in the Annals of the South African Museum (vol. iv., p. 376, 1908) from some fragmentary remains of the skull of a presumably temnospondylous Labyrinthodont found near Prince Albert, Cape Colony, to which the specific name *R. whaitsi* was given. The genus was said then to include also the species named by Lydekker *Eryops africanus* and the European species called *Macromerion Gümbeli* by von Ammon. At first the genus was thought to have no affinities with *Eryops*, but later (1910, Bull. Amer. Mus. Nat. Hist., xxviii.) Broom modified this view, concluding that the two genera were apparently closely allied. In 1911 van Hoepen (Ann. Transvaal Museum, iii., 2) described part of a skull of a large Labyrinthodont from Senekal, O.F.S., as *Myriodon senekalensis*, while in 1912 Broom described part of another skull from the same place as *Rhinesuchus major*. Recently, thanks to the courtesy of the authorities of the Bloemfontein Museum, I was enabled to examine the beautiful Labyrinthodont skeleton which they obtained from Senekal. In addition to that specimen I have also examined a skull from Beaufort West, a crushed skull from the Nieuweveld (both collected by the Rev. J. H. Whaits), and a portion of lower jaw from Senekal. These three latter specimens are in the collection of the South African Museum.

The original description of the genus *Rhinesuchus* as given by Broom is as follows:—

"Skull probably like that of *Capitosaurus* in general shape; maxillaries and dentaries each bearing a row of uniform teeth; inside of maxillary teeth are large numbers of very small teeth, probably borne by palatines, and covering much of the pterygoids and continued across the back part of the parasphenoid: similar small teeth are found inside of the teeth borne by the dentary; they

are probably on the splenial bone ; the median anterior part of the parasphenoid is narrow."

The following is a translation (the original paper is in Dutch) of van Hoepen's description of the genus *Myriodon* :—

"Skull triangular, rounded in front, almost as long as broad. Maxilla and dentary bear each a row of large, conical, pointed, pleurodont, flattened teeth, becoming smaller posteriorly, probably labyrinthodont in section. Within the row of maxillary teeth, probably on the palatine, is a row of large teeth, similar to the maxillary and dentary teeth. On the remaining bones of the palate are large numbers of small teeth, of which the biggest is far smaller than the large teeth already mentioned. Similar small teeth are found on a ridge which runs along the row of teeth on the dentary." Van Hoepen further says that his genus differs from *Rhinesuchus* in that it has but one row of teeth on the palatine, and lacks the small teeth on this bone.

The fragment of skull upon which Broom based his description of the palatine bone is in a crushed condition, and it is probable that these supposed palatine teeth are on the prevomer. In the complete skull of *R. whaitsi* which I describe in this paper there is a row of medium-sized teeth lying on the inner border of the internal nares which are almost certainly carried by the prevomer. I am unable to find in the type fragments any justification for the statement, "Inside of maxillary teeth are large numbers of very small teeth, probably borne by palatines." The only fragments which show small teeth are portions of the lower jaw, which bear the usual coronoidal teeth lying internal to the larger teeth of the dentary.

For these reasons the two genera must be grouped together under the one generic name—*Rhinesuchus*, Broom—for which the following short diagnosis may stand :—

"Medium-sized to large temnospondylous Labyrinthodonts. Skull triangular, rounded in front, median length slightly greater than breadth. Eyes wholly in posterior half of skull. Otic notch present. Bones of skull-roof complete. Maxillary and dentary each carrying row of uniform teeth, slightly decreasing in size posteriorly. Prevomer carrying one or more large tusks, a few medium-sized teeth, and covered—together with the major parts of the parasphenoid and the pterygoid—with minute denticles. Palatine with row of teeth similar to those on maxilla. Small transpalatine with teeth present. Coronoid carries number of denticles on upper surface."

Besides having the eyes larger and set more nearly together, and

in being more pointed, the skull of *Rhinesuchus* differs from that of the American genus *Eryops* in lacking the interfrontal bone. I have searched carefully for evidence of this bone in all the species, but can find none. Moreover, although the lower jaws I have examined are not in the best condition for showing sutures, I am not able to find any tripartite division in the coronoid bone.

Rhinesuchus whaitsi, Broom.

(Plate XII., figs. 3, 4. Text-fig. 7.)

1908. Broom, Ann. S. African Mus., iv., 8, p. 373; pl. xlvi., fig. 3.

An almost complete skull and lower jaw (S.A.M. Cat. No. 3009) collected by the Rev. J. H. Whaits at Beaufort West (*Endothiodon* zone of Beaufort Beds) enables me to give more details concerning this species.

In its general outline the skull has a shape like that of *Eryops megacephalus* and *Rhinesuchus senekalensis*. The upper surface of the skull and the outer surface of the lower jaw are covered with a pitted sculpturing. In the snout and mid-regions of the skull the pits are roughly circular; in the jugal, quadratojugal, and squamosal regions the pits are more elongated. The orbits are wholly in the posterior half of the skull and are comparatively more nearly set together than in *Eryops*. The articular region extends well behind the occiput. The following are some of the principal measurements of the skull:—

Maximum length	312	mm.
Length on median line	265	,,
Maximum width	258	,,
Interorbital width	40	,,
Internasal width	41	,,
Length from back of nostril to front of orbit	125	,,
Length from plane of snout to front of orbit	158	,,
Length of orbit	33	,,
Width of orbit	34	,,

Comparison with the type specimen of *R. whaitsi* shows that the skull is flattened, but the width and general size of the parasphenoid and the pterygoids, as far as they can be compared, leave no doubt that this skull belongs to the species already described. Unfortunately the sutures on the top of the skull are not visible, but the structure of the palate can be made out fairly well.

The parasphenoid has a flat posterior portion similar to that

figured by Broom in his description of this species, and passes forward between the large vacuities to meet the prevomer. As in the type the anterior part of the plate bears a number of tiny denticles. Posteriorly the bone covers a large part of the basi-occipital. The lateral articulations with the pterygoids are of the type seen in *Eryops*.

The pterygoid forms most of the posterior and outer walls of the large vacuity. Behind the parasphenoid the pterygoid passes backwards and downwards, articulating with the squamosal and overlying the inner half of the quadrate. Laterally it passes forward outside the large vacuity to meet the prevomer, articulating on its outer border with the palatine. From the posterior corner of this bone, just behind the level of the parasphenoid, the surface is covered with small denticles save for a narrow band on the inner side along the wall of the vacuity. This non-dentigerous band is about 50 mm. long, and at its widest—at the posterior end—has a breadth of 13 mm. In the type specimen there is also an outer non-dentigerous band. As the bone narrows anteriorly the denticles tend to become arranged in well-defined rows.

The palatine lies between the maxilla on the outside and the pterygoid and prevomer internally. It bears one row of large teeth, of which the first two are larger and more tusk-like and the remainder small and flattened, so that the breadth is greater than the length. There is a slight decrease in size of the teeth posteriorly. The few that are preserved entire show that the teeth were simple, pointed, and conical, with very slight longitudinal grooves. Just behind the internal nares, internal to the row already described, and possibly on the palatine, is a secondary row of three or four similar teeth.

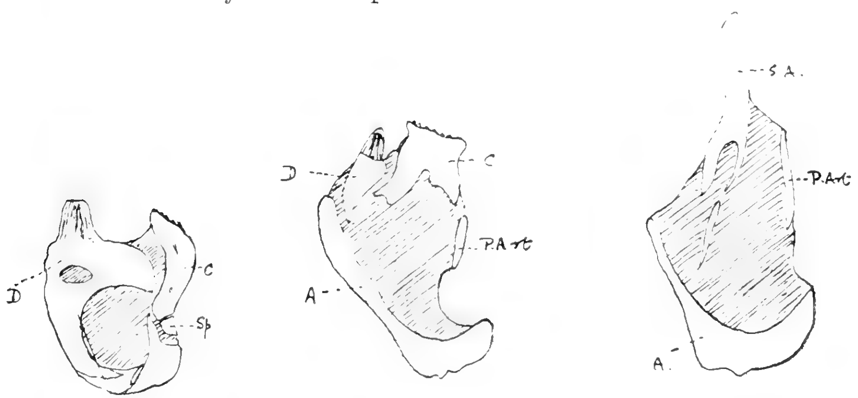
I am unable to say definitely that a transpalatine is present; but behind and outside the palatine is a small mass of bone slightly below the level of the palatine bearing three or four medium-sized teeth. This may be the transpalatine.

The prevomer is large. The pair of bones lie between the posterior nares forming most of the front of the palate. On the outside of the large vacuity they pass back to meet the pterygoids, and between the openings they send back a long process to meet the parasphenoid. In front of the posterior nares are two large tusks. Between the hinder pair of these is a transverse row of smaller teeth, each prevomer bearing three. Between this row and the posterior vacuities is a very well-defined dentigerous area coered with denticles, which area passes backwards almost, if not quite, to the pterygoids.

The premaxilla carries teeth along its border, as does the maxilla.

The quadrate is a triangular bone lying between the pterygoid and the quadrato-jugal and squamosal. It appears mostly on the back of the skull, the apex of the bone lying 32 mm. above and some distance internal to the articular surface. This latter is weakly concave, the concavity being directed backwards and outwards from the anterior inner angle of the bone.

Passing outwards and backwards from the posterior lateral curved border of the parasphenoid is a small, thin, apparently plate-like bone. This may be the stapes.



α. *β.* *γ.*

Fig. 7.

Sections across left ramus of lower jaw of *Rhinesuchus whaitsi*:
- *α.* 85 mm., behind point of jaw.
- *β.* 185 mm., behind point of jaw.
- *γ.* 220 mm., behind point of jaw.

D, dentary; C, coronoid; Sp, splenial; A, angular; P.Art, Prearticular; S.A., surangular.

The whole of the left side of the lower jaw is preserved, together with the articular region of the right. The length of the jaw is about 322 mm.

The dentary carries a row of labyrinthodont teeth. It has a narrow posterior elongation extending towards the articular surface for some distance behind the last tooth.

Lying along the inside of the dentary and extending almost from the front of the jaw to the anterior border of the supra-Meckelian fossa is the "coronoid," which throughout nearly the whole of its length bears a large number of small teeth. In the jaws of *Trimerorachis* and *Eryops*, as described by Broom and by Williston, this "coronoid" consists of three elements—the coronoid proper,

the intercoronoid, and the precoronoid. Unfortunately the bones of the lower jaw in this specimen are somewhat crushed; but, except for a possible line of suture between a precoronoidal portion and the remainder of the bone, I am unable to distinguish the three elements each from the other. Moreover, the whole series of coronoidal teeth is evenly distributed; no portion of the upper surface of the bone bears an augmented share, and none is without teeth, whereas in the figure given by Williston of the jaw of *Trimerorachis alleni* the "coronoidal" teeth are grouped in three well-defined areas, the edges of the upper surface of each of the three elements being non-dentigerous.

The lower jaw is of much more slender build than that of *Eryops* or of *Trimerorachis*, and the supra-Meckelian fossa considerably smaller in proportion. Viewed from within, the posterior flattened expansion of the prearticular completely hides the fossa and surangular from view.

A fragment of the right jaw shows what is apparently a distinct suture between the splenial and the postsplenial, the latter of which is the preangular of Broom. This suture occurs below the front margin of the small anterior fossa.

Rhinesuchus senekalensis (v. Hoepen).

(Plate XII., figs. 1, 2.)

1911. *Myriodon senekalensis*, van Hoepen. Ann. Transvaal Mus. iii., 2, p. 103; pls. 1, 2.

1912. *Rhinesuchus major*, Broom. Trans. Geol. Soc. S. Africa, xiv., p. 79; pl. xiii., 1–2.

The types of van Hoepen and Broom were obtained at Senekal. From the same place came the almost perfect specimen now in the Bloemfontein Museum, which I was able to examine by permission of the authorities of that Museum, and of which a cast was made for the South African Museum. In addition there is in the South African Museum a portion of the left mandible and the left maxilla of the same species, also from Senekal, presented by the late H. Kynaston, Esq.

The following description of the species is based mainly on the Bloemfontein specimen. This shows the whole of the upper side of the animal crushed flat on a slab of sandstone, together with some of the ventral armour. The front legs lie bent backwards along the sides of the body, while the hind legs are spread out at right angles to the trunk. Unfortunately the sutures of the skull can scarcely

be made out among the sculpturing of the surface, and in this connection I have made use of the facts given by Dr. Broom. The specimen described by him seems to be a smaller representative of the species than the Bloemfontein one; but from the general similarity and from the fact that all the known examples come from the same locality, I think there can be no doubt as to their specific identity. Comparison of the photograph of the Bloemfontein specimen with the restoration of the skull given by Broom shows that in the latter the snout is somewhat too long, the nostrils being nearer the front of the skull.

As preserved, the animal measures nearly 7 feet in length. There are only five caudal vertebrae showing, so that the length may have been nearly 8 feet in life, supposing that the tail was short as in *Eryops*.

The skull is moderately long with a rounded snout and practically straight sides, flat, and broadest at the back. It has the pitting characteristic of this genus and *Eryops*, the pits being roughly circular in the middle of the bones and lengthening out towards the edges. The otic notch is not large. The nasal-frontal region is furnished with a median groove, and on either side is a bow-shaped channel running from the plane of the back of the nostrils to that of the front of the orbits, concave towards the median line.

The greatest length of the skull is 580 mm., the greatest breadth 444 mm. The nostrils lie 33 mm. from the front of the snout, and the orbits 308 mm. There is a small pineal foramen 407 mm. behind the snout. The internasal width is 53 mm., the interorbital width 57 mm. (Broom's specimen has an interorbital width of 50 mm.). From the orbit to the nostril the distance is 235 mm. (Broom's specimen gives 203 mm.).

No sutures can be seen in the preorbital region save parts of the boundary of the prefrontal. This is a very large bone. Broom says: "The frontal bones are long and narrow, and separated from the orbits by the forward extension of the postfrontals, agreeing in this with *Archegosaurus*. The prefrontal is very large, stretching more than half-way to the nostril. The nasal bone is also very large. The lachrymal is narrow and placed well forward. The jugal is large and forms about a quarter of the side of the head. It only forms a small part of the orbital margin. Behind it is the large prosquamosal, or, as it is more often called, the supratemporal. The postorbital comes well down behind the orbit."

In the Bloemfontein specimen it is possible to delimit most of the posterior cranial bones, partly from the sutures and partly from

the sculpturing. The quadrato-jugal forms the outer posterior angle of the skull, articulating with the squamosal, jugal, and probably with the maxilla. The squamosal is a fairly large pentagonal bone forming the outer boundary of the auditory notch, having a well-defined junction with the suprasquamosal, and probably meeting the postorbital in front. The suprasquamosal forms a small part of the boundary of the auditory notch, the inner wall of which is formed by the tabulare. The pineal foramen lies wholly in the parietals, which are rectangular bones.

The postorbital apparently extends further out from the orbit than in *Eryops*. The postfrontal is small, and the frontal is completely excluded from the orbital border. The jugal forms about 30 mm. of the outer border of the orbit, and is the largest bone on the surface of the skull. The postparietal has an almost square cranial portion, and is larger than the corresponding bone in *Eryops*. The superficial cranial bones completely hide the exoccipital condyles in a view from above.

Nothing can be seen of the palate. Several teeth are seen along the edge of the maxilla, each about 15 mm. long. They are simple, pointed, unserrated.

Vertebral column.—There are 29 vertebrae between the occiput and the sacrum. Most of the dorsal spines are missing, and the ventral side of the column has not been exposed. The left-hand sides of most of the intercentra are displayed, and all the neural arches. As in *Eryops*, the neural arch of the first vertebra consists of two halves, the anterior portions of which articulate with the exoccipital condyles, and the upper portions of which pass backwards along the sides of the dorsal spine of the axis. Each half of the atlantal spine has an articular width of 32 mm. and is 54 mm. long.

From the axis to the sacrum the neural arches are approximately similar. There are well-marked transverse processes for the articulation of the ribs. From the 7th vertebra to the sacrum the width across the transverse processes gradually decreases. The following gives the measurements of two of the best-preserved vertebrae :—

	13th vertebra.	22nd vertebra.
Length of arch	45 mm.	52 mm.
Length of dorsal spine	36 ,,	27 ,,
Height of spine above transverse process	31 ,,	29 ,,
Width between extremities of processes...	88 ,,	61 ,,

All the vertebrae carry ribs. The ribs from the 2nd to the 8th have their distal thirds strongly expanded with a well-defined

superior process from the expanded portion. The ventral portion of the expanded end is bent inwards and lies below the next succeeding rib.

Shoulder girdle.—Only the upper end of the scapula on each side is seen. The bone is a thin flat blade with an antero-posterior length at its extremity of 75 mm., and with an average thickness of not more than 8 mm. The upper border is approximately straight and posteriorly it is produced, so that the posterior angle is acute while the anterior angle is obtuse.

The cleithrum differs in shape from that of *Eryops*. It has a length of at least 210 mm., and is closely applied to the anterior border of the scapular blade and to the outside of the anterior end of the upper border. For at least half of its length it is overlain by the clavicle. It is a strong bone, spatulate at its distal end when viewed from above, and not possessing the fan-shaped expansion seen in *Eryops*. It extends back beyond the scapula, not in contact with most of the upper border of that bone, and it almost covers the scapula when viewed from above.

The upper part of the clavicle lies in front of and upon the cleithrum. It is expanded and somewhat spoon-shaped when seen from above, with an inner pointed distal angle. Its maximum width is 46 mm. Proximally it is curved inwards to meet its neighbour beneath the interclavicle, which is not seen ; the proximal portion of the bone is more rounded in cross-section than the distal expanded portion.

Fore-limb.—Of the humeri only the distal ends have been displayed, and they have been mutilated to a certain extent, so that it is not possible to give any details of their form.

The radius and ulna of both fore-limbs are lying in position. The radius is a single shaft with slightly expanded ends, 80 mm. long, with a minimum width of shaft of 16 mm. The proximal end has a width of 27 mm., and is hollowed for articulation with the humerus. The distal end has a width of 24 mm., and has two articulating faces. The inner one is comparatively short, while the ulnar surface is much longer and nearly flat.

The ulna has a form similar to that figured by Case for *Eryops*. The olecranon process is very blunt. The radial border of the bone is concave, the outer border straight from the head to the beginning of the distal expansion. The length of the ulna is 82 mm. The outer angle of the distal end is bluntly rounded for articulation with the pisiforme, while the main surface is truncate.

The carpus of *Eryops* has been discussed by Cope, Emery, Broom, and Case. In the specimen under description only two elements of the carpus remain—the "carpus" seen on the right limb being merely lumps of matrix that have been painted black and photographed before their true nature was noticed. There were undoubtedly four elements in the proximal row. The element remaining, the intermedium, articulated with the lower part of the ulnar surface of the radius. It is a lozenge-shaped bone 20 mm. by 12 mm. in extent. Internal to it was the radiale. Articulating with the intermedium, radius, and ulna was the ulnare—to follow Broom's interpretation of the *Eryops* carpus; and articulating with the external surface of the ulna was the pisiforme, probably small. The other bone of the carpus remaining is imperfect, and is probably the 2nd carpale.

The metacarpals are more slender than those of *Eryops*. Only four metacarpals and four digits are preserved on each side, and the phalangeal formula as preserved is 2, 2, 3, 3 (?) or 4. The following table gives the chief measurements:—

	Length in mm.	Proximal width in mm.
1st metacarpal	23	15
1st phalanx	15	14
Claw	11	11
2nd metacarpal	29	14
1st phalanx	21	15
Claw	12	11
3rd metacarpal	28	17
1st phalanx	19	14
2nd phalanx	17	10
Claw	?	?
4th metacarpal	23	15
1st phalanx	16	12
2nd phalanx	12	9

Pelvis.—The pelvis is remarkable for the shape of the ilium. In the possession of a backwardly directed superior process and the absence of any superior anterior portion, the bone is more strongly reminiscent of such reptiles as *Varanosaurus* and *Ophiacodon* than of *Eryops* or the Cotylosaurs. The posterior process of the ilium slopes backwards and somewhat upwards, and has a rounded superior margin. The anterior margin is slightly convex, and there is no

preacetabular process. The inner border is concave behind the attachment of the sacral rib.

The pubes are large and plate-like, broadly expanded in front with a convex anterior margin.

Hind limb.—The hind limb of each side is preserved almost completely, the only missing bones being one or two from the tarsus.

The femur is approximately straight, with expanded extremities. The total length is 170 mm. The proximal end is swollen posteriorly, and apparently somewhat flattened anteriorly. The maximum width of the proximal end is 62 mm., and of the distal end 55 mm. The distal end has two prominent flattened articular surfaces. The shaft is moderately robust, with a minimum antero-posterior diameter of 25 mm.

The tibia and fibula are bones with widely expanded extremities, each bone being about half the length of the femur. The distal end of each bone has apparently two faces, the tibia articulating with the tibiale and intermedium, and the fibula with the intermedium and fibulare.

Most of the structure of the tarsus and pes is satisfactorily shown, although two of the tarsalia are missing. The intermedium is applied closely to the inner condyle of the fibula, lying between that bone and the tibia. It is irregularly rhomboidal in shape on the dorsal surface; the length of the fibular side is 25 mm., its width is 25 mm., and its height 28 mm. The tibiale and fibulare are both lozenge-shaped bones, each articulating with the intermedium. The tibiale is the larger bone, having a width of 36 mm. and a height of 19 mm., while the fibulare is 24 mm. wide and 19 mm. high.

Of the tarsalia but two are preserved—the first and what is probably the third. The first tarsale supported exclusively the first metatarsal. It is rectangular in shape, 16 mm. wide and 12 mm. high. The third lies in such a position that it probably assisted in the support of both the third and fourth metatarsals, a view which is borne out by its ovoid shape. It is smaller than the first tarsale, with a width of 15 mm. and a height of 10 mm. Lying between the tibiale and the first tarsale is a small rectangular bone measuring 12 mm. by 6 mm. This is the centrale.

The foot is short and heavy, larger than that of the fore-limb. All the metatarsals are somewhat expanded at the extremities, the first and last being shorter than the others. The digital formula is 2, 2, 3, 4, 3. The ungual phalanges are short and very bluntly

pointed, as in the fore-foot. The following are the chief measurements of the bones of the digits in millimetres :—

	Length in mm.	Proximal width in mm.
1st metatarsal	24·5	18
1st phalanx	15	18
Claw	approx. 10	13
2nd metatarsal	36	21
1st phalanx	26	19·5
Claw	approx. 11	12
3rd metatarsal	38	19
1st phalanx	24·5	20
2nd phalanx	17	15
Claw	11	11
4th metatarsal	37	19
1st phalanx	24	19
2nd phalanx	15	15
3rd phalanx	12	10
Claw	missing	—
5th metatarsal	23	16
1st phalanx	21	15
2nd phalanx	16	12
Claw	11	8

Armour.—The whole of the under side of the body was covered with an armour consisting of elongated, overlapping scales arranged in diagonal rows. The length of each scale in the mid-ventral region is about four times the width. Each scale, viewed from above, has a median groove, with one or two interrupted and narrower lateral grooves. Broom, in his description of a specimen from Senekal, says : "The armour consists of elongated, imbricated scales. One set of scales, probably from near the middle line, are much flattened and almost identical in appearance from those of the middle region of the abdomen of *Eryops*. The other series are probably from the more lateral region, and are narrower and less flattened."

RHINESUCHUS AFRICANUS (Lydekker).

1890. *Eryops africanus*, Lydekker. Quart. Journ. Geol. Soc., xlvi., p. 291 ; pl. xii., fig. 2.

This species was described by Lydekker from a somewhat incomplete mandibular ramus obtained from some unknown locality in the Karroo, and was placed in the genus *Rhinesuchus* by Broom.

The species is imperfectly known. A crushed and incomplete skull and lower jaw (S.A.M. Cat. No. 3010) collected by the Rev. J. H. Whaits at Dunedin, Nieuweveld, Beaufort West (*Cistecephalus* zone), probably belongs to the species. It shows a type somewhat smaller than *R. senekalensis*, with a basal length of about 400 mm. The lower jaw is more robust than that of *R. whaitsi*, and there is no subdivision of the coronoid bone. More material is necessary before the details of this species can be satisfactorily determined.

6. *On a New Type of Dinocephalian* (Moschosaurus longiceps).

(Text-figs. 8, 9.)

The skull on which this new genus is founded was collected in 1914 on the farm La-de-da in the Division of Beaufort West from beds belonging to probably the upper part of the *Pareiasaurus* zone. With it were preserved half a dozen vertebrae, almost without doubt anterior dorsals.

The skull is long, low, and narrow, and although there is a slight elevation in the parietal region, there is none of the tremendous thickening of the bones which is so prominent a feature of the larger Dinocephalians such as *Tapinocephalus* and *Struthiocephalus*. The nostrils are rather far back. The eyes are wholly in the posterior half of the skull and are larger than the temporal openings. The quadrate is carried forward to the plane of the middle of the orbit. The lower jaw is massive.

The front of the nostril is 60 mm. behind the tip of the snout. The nostrils are large, longitudinally oval, and the internasal width is 20 mm.

The premaxilla has a suture with its fellow, and together the bones form the rather pointed extremity of the snout. Superiorly they separate the nostrils, sending back a narrow process to separate the anterior portions of the nasals. The suture with the maxilla is doubtful, but each premaxilla bore three or four large teeth. Each tooth is carried in a separate socket. The roots are long, and the crowns are differentiated into a long anterior cusp and a smaller posterior one. The antero-posterior width of the crown is at least $1\frac{1}{2}$ times the width of the root, the posterior cusp of the crown being a sort of process some distance above the level of the anterior cusp. Similar teeth are known from other and larger Dinocephalians. In *Struthiocephalus* the outside of the crown is convex and the anterior cusp is bluntly pointed, while the interior surface is concave below the posterior cusp which is convex on both sides. In some of the teeth in that genus there are one or two longitudinal grooves on the inside of the crown.

The maxilla is a large bone forming the lower border of the nostril and apparently passing back to form part of the sub-orbital arcade. It carried probably 6 or 7 teeth, of which only one or two are preserved. The posterior teeth are smaller than the anterior. The first may have functioned as a canine, being apparently bluntly pointed, but it was certainly comparatively much smaller than the canine of *Titanosuchus.*

The facial part of the septomaxilla is small, forming part of the posterior wall of the nostril and separating the maxilla and nasal for a short distance.

The nasals form a well-marked upstanding ridge between the nostrils and orbits along the centre of the skull, a region well marked off from the cheeks, which slope at an angle of about 50° from the jaws and are concave directly in front of the orbits. This nasal ridge is wide in its posterior part, suddenly narrows, and then has a uniform width of about 30 mm. throughout the anterior two-thirds of its length.

The orbit lies wholly within the posterior half of the skull, is longer than high, and shows very little supraorbital thickening. The prefrontal forms the anterior upper quadrant of the orbital margin, but its front margin is not well delineated.

The lachrymal is smaller than the prefrontal and does not reach the septomaxillary.

The interorbital area has a width of nearly 80 mm. It is flat, formed mostly by the frontals, which form a small part of the superior borders of the orbits.

The postorbital bar is comparatively weak, but the postorbitals pass back to form a large part of the upper border of the temporal fossa. The parietals are not distinguishable, but they must have been small.

The pineal foramen is sub-circular in shape and very large, having a longer diameter of 26·5 mm. The parietal region surrounding it was raised slightly above the level of the frontals. The foramen is placed very far back, in the plane of the back of the temporal fossa.

The squamosal, quadrato-jugal, and jugal occupy apparently the same relations as in *Moschops* and *Delphinognathus*, but there is no foramen between the jugal and quadrato-jugal such as occurs in *Delphinognathus.* The quadrate is scarcely seen from the side of the skull. It is pushed forward by the large squamosal to the level of the middle of the orbit. From behind it is roughly boot-shaped with the "heel" internal and the "toe" pointing outwards and

slightly forwards. The articular of the lower jaw is closely applied to it.

The occipital plate is weathered and broken. There is a large foramen magnum placed high up. The squamosal only forms the edge of the plate and the outer boundary of the lateral post-temporal fossa. Most of the side of the occipital plate seems to be formed by the tabulare. Below the basioccipital condyle there is a vertical mass of bone as in the other Dinocephalians.

The lower jaw is deep and displayed only in outer view. Its total length is about 215 mm. The dentary covers almost the whole of the anterior half of the jaw, the lower border being formed by the

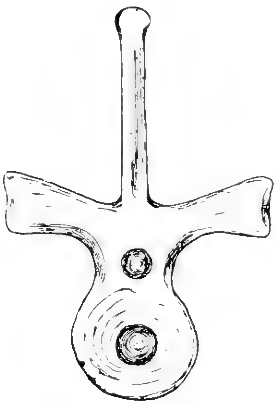


FIG. 8.—Anterior view of vertebra of *Moschosaurus longiceps*. $\times \frac{1}{2}$.

splenial; and the dentary extends backwards along the upper border of the jaw for about four-fifths of its length. This posterior process is much more slender than that seen in *Dimetrodon*. The dentary carries 5 or 6 teeth, forwardly directed and presumably diminishing in size posteriorly.

The splenial forms a small portion of the symphysis and is only visible along the lower border of the anterior half of the jaw.

The back of the angular is missing; but the notch in its lower border must have been a small one. The bone overlaps the articular which, from below, is seen to be swollen vertically and to pass forwards and upwards.

Six consecutive vertebrae are preserved, without doubt anterior dorsals. The centra are short with circular biconcave ends. The lower border is concave with a slight median ridge. The sides are

more concave than the ventral surface. The transverse processes are large, pointing slightly upwards, thicker distally than proximally. The neural spines are high and flattened laterally.

The following table gives the measurements of three of the vertebrae, the 1st, 3rd, and 5th of the series:—

	1st Vertebra.	3rd Vertebra.	5th Vertebra.
Length of centrum	30 mm.	33 mm.	32 mm.
Height of centrum	28 ,,	31 ,,	31 ,,
Total height	88 ,,	112 ,,	117 ,,
Width across transverse processes	70 ,,	68 ,,	? ,,
Height of spine	35 ,,	52 ,,	58 ,,
Length of spine	17 ,,	23 ,,	22 ,,

No intercentra are preserved.

This type, although undoubtedly a Dinocephalian, presents in its external shape so great a contrast to the other members of the group that I propose to erect for it a new genus, and to name it *Moschosaurus longiceps*, g. et sp. nov.

Type. Skull and lower jaw. (S.A. Mus. Cat. No. 3015.)

Locality. La-de-da, Beaufort West, Cape Colony.

Horizon. Lower Beaufort Beds. (Upper part of *Pareiasaurus* zone.)

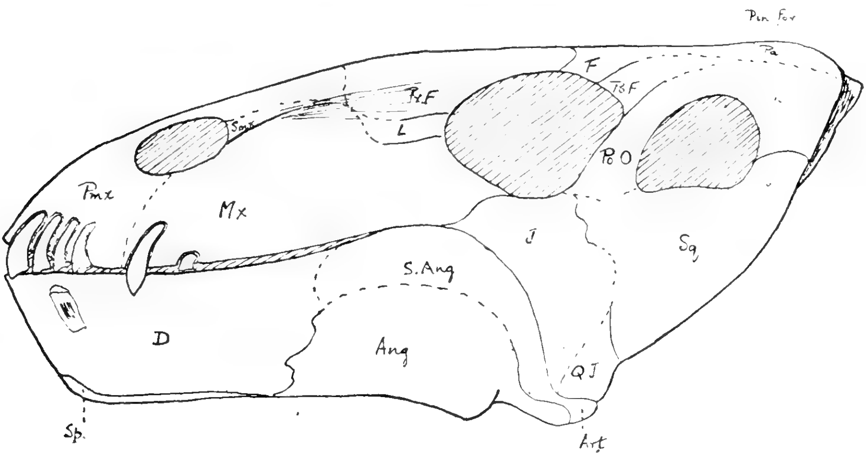


FIG. 9.—Skull of *Moschosaurus longiceps*. × ⅓.

7. *On Some New Gorgonopsians.*

1. Galesuchus gracilis, g. et sp. nov.

(Text-figs. 10, 11.)

This new genus and species is founded on a specimen collected at Abraham's Kraal, Prince Albert Division, that is, from the lower half of the *Pareiasaurus* zone, where it occurred in conjunction with *Trochosaurus intermedius* and bones of *Pareiasaurus* and of large Dinocephalians. It is a weathered skull and lower jaw, lacking the anterior part in front of the canine.

The skull is small. As preserved its greatest length is 120 mm., while the maximum width across the squamosals was probably 75 mm. The orbits look outwards, and the antorbital portion seems not to have been quite so elongated as in the Gorgonopsians from the *Endothiodon* and *Cistecephalus* zones. The antero-posterior diameter of the orbit is 32 mm., and the interorbital width 30 mm., being equal to the intertemporal. The temporal fossa looks upwards and outwards. The occiput is very sloping, inclined at an angle of not much more than 30° to the top of the skull.

The canine is fairly large and vertical. The molars are small, four in number, simple, unserrated, and slightly recurved. The maxilla is deep, with a posterior slender process passing below the jugal to the plane of the middle of the orbit.

Both the prefrontal and lachrymal are large, while the jugal forms part of the anterior, and the whole of the inferior, borders of the orbit. The prefrontal forms the whole of the anterior superior quadrant of the border.

The frontal is large, forming 5 mm. only of the orbital border. It passes backwards, supporting the median preparietal, and articulating also with the parietal and postfrontal.

The postfrontal is large, and forms a large part of the upper border of the orbit, having the same general shape as in *Scylacops capensis*.

The preparietal is 15 mm. long, and lies 4 mm. in front of the pineal foramen, which is 5 mm. long and oval in shape.

The parietals are large, and wholly enclose the pineal foramen. Owing to weathering of the bone surface their relations with the squamosals cannot be determined.

The interparietal forms the upper half of the occipital plate and articulates below with the supraoccipital.

The foramen magnum is large, oval in shape. Its lateral borders are formed by the small exoccipitals. The basioccipital condyle

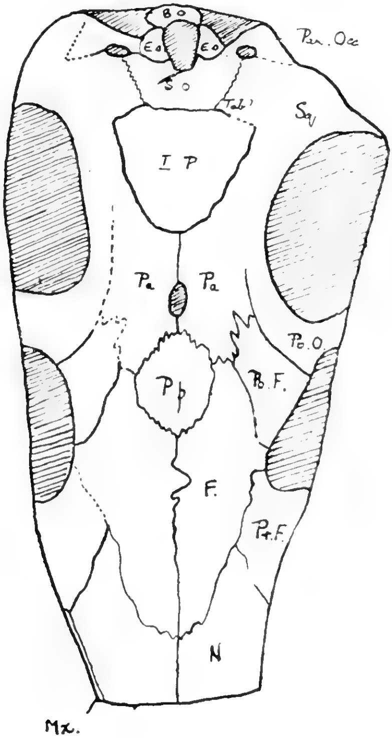


FIG. 10.—*Galesuchus gracilis.*

Sketch of top of skull showing arrangement of bones. × $\frac{2}{3}$.

is rounded. The basisphenoidal tubera are far back and considerably below the level of the condyle, so that the foramen magnum appears to be high up on the back of the skull. The paroccipital process is deep and strong, and the post-temporal fossa is as high as the top of the foramen magnum, looking wholly backwards. The foramen jugulare is not seen, but it must have been high up as in *Arctops.*

The condition of the matrix renders it almost impossible to develop

the palate, but fracturing of the specimen has shown one or two of its features. The descending processes of the pterygoids are large. As in *Scylacops capensis* and other Gorgonopsians the pterygoid is closely united with the transpalatine, there being no evidence of any foramen between them. The ascending pterygoidal plates pass forward above the palatine. Superiorly the fused pterygoids thin out into a plate slightly displaced from its true position, which does not appear to meet the ethmoid, although the two bones may have met further back. The ethmoid is a median element lying vertically beneath the frontal suture, and separated from the upper cranial wall.

The palatine carries a few simple pointed teeth.

Only the posterior half of the vomerine bone is seen. It descends below the level of the front of the palatine, which ascends anteriorly towards the top of the skull as a thin plate. Between this plate and the vomerine bone is a distinct foramen. This bone is apparently single.

The lower jaw is incomplete, but agrees in external characters with that of *Scymnognathus*. The dentary is very large, and its posterior process rather more powerful than in the other Gorgonopsians. The angular is large.

Type. Incomplete weathered skull. (S.A.M. Cat. No. 2754.)

Locality. Abraham's Kraal, Prince Albert Division.

Horizon. Beaufort Beds. (*Pareiasaurus* zone.)

2. Gorgonognathus longifrons, g. et sp. nov.

(Plate XIII., figs. 1, 3.)

The skull about to be described is No. 2671 of the South African Museum collection, and was collected at Dunedin, Beaufort West, from a bed of sandstone 1½ miles east of the homestead. The top of the snout and back of the temporal region are denuded of bone by weathering, and the whole skull is somewhat distorted. The general features of the skull are those of *Gorgonops torvus*, which occurs, however, at a lower horizon: but the head is not quite so much depressed, and is much larger than Owen's type.

The maximum length of the skull was between 340 mm. and 350 mm. From the snout to the front of the orbit is 200 mm. The basal length from the snout to the back of the occiput is 305 mm. The interorbital width is 77 mm., while the intertemporal width was probably about 85 mm.

The premaxilla is divided by a median suture. The septomaxilla

and maxilla have the normal Gorgonopsian relationships. The septomaxilla is large, and has the inwardly directed turbinal process dividing the nares into upper and lower passages. It forms an appreciable portion of the cheek behind the nostril, and has the usual outer foramen between it and the maxilla. The nostrils are nearly terminal.

The maxilla is large, forming nearly three-quarters of the cheek, and having a sub-orbital portion supporting the jugal.

The dental formula is $i5$ $c1$ $m4$. Most of the teeth are missing, only the fourth incisor on either side being present, but the sockets are plainly visible. The incisors are large, nearly equal in size to one another, and closely set together, the five teeth occupying a space of 54 mm. at the edge of the bone. At that level the 4th incisor has an antero-posterior diameter of 11 mm The roots of the teeth are long and simple. Each tooth is implanted in a separate socket. Behind the last incisor is a diastema of 14 mm., and then comes the socket of a massive canine 28 mm. in diameter. Directly behind the canine is a series of four molars—all lost—gradually decreasing in size, and occupying together a space of 33 mm.

The nasals are very large, forming the top of the snout, and having posterior projections which separate in part the frontals from the prefrontals.

The prefrontal is large, forming the upper anterior quadrant of the orbital border. The frontal is largely shut out from the orbital border, but it forms 13 mm. of it between the prefrontal and postfrontal. It passes forward, separating the posterior parts of the nasals.

The orbit is small, looking forwards and outwards and possibly slightly upwards, and lies wholly in the posterior half of the skull. The postfrontal is large, forming nearly one-fourth of the orbital margin, and articulating apparently with the parietal to behind the pineal foramen.

The temporal fossa is slightly larger than the orbit. The intertemporal region is wide, and the pineal foramen is placed back almost as far as the occipital crest. The preparietal is small, and wholly in advance of the pineal foramen.

The squamosal forms the lower and most of the posterior borders of the temporal fossa and the outer sides of the occipital plate. The lower part of the bone and the quadrate region are missing.

The occipital plate is broader than high, and vertical. The interparietal is slightly broader than deep, and forms a large part

of the plate. It has a prominent median ridge in its lower half, which barely passes over to the bone below.

The most recent accounts of the basicranial region of the Gorgonopsia have been given by Watson, who describes skulls of *Arctops willistoni* and *Scymnognathus whaitsi*, discussing their relations with *Dimetrodon* on the one hand and *Diademodon* on the other. In *Gorgonognathus* the basioccipital condyle is rounded and swollen below, and hollowed above for the reception of the foramen magnum. The paroccipital process is short and powerful, forming the lower border of the post-temporal fossa. It is considerably in advance of the tabulare, and shallow when viewed from behind, so that the post-temporal fossa looks almost wholly downwards. The exoccipitals are like those figured by Watson, and form the lateral borders of the foramen magnum. The foramen jugulare is at the bottom of the skull in front of the exoccipital, bounded by that bone, the paroccipital, and the basioccipital, and looks wholly downwards.

The whole occiput is concave and the squamosals fairly wide. The interparietal is narrow and the tabulare large as in *Scymnognathus*. The interparietal carries a well-marked median ridge, which dies out below on the supraoccipital. The tabulare forms the outer upper border of the post-temporal fossa, and covers part of the back of the inner ramus of the squamosal.

Thus this form, occurring as it does in the *Cistecephalus* zone, seems to occupy rather an anomalous position. In the width of the parietal region, the shortness of the temporal fossae, the shape of the basioccipital condyle, and the stoutness of the paroccipital it agrees with *Arctops*. But in the reduction in height of everything below the foramen magnum, the downward aspect of the post-temporal fossae, the position of the foramen jugulare, and the size of the squamosal, interparietal and tabulare it agrees with *Scymnognathus*, indicating possibly an advance on that form.

The palatal view of the premaxilla shows a somewhat pitted flat plate anteriorly, which forms part of the inner border of the large internal narial openings, and articulates behind with the "vomer."

This vomer is comparatively broad anteriorly and narrows behind. It has ventrally a median keel and two lateral keels, with slight intermediate grooves. Although the median suture separating the two premaxillae can be well seen, there is no suture running down the middle of this bone, and it is undoubtedly a single bone. For some time Dr. Broom has considered that this median bone is a

pair of fused prevomers, and Watson has recently mentioned that in the type skull of *Arctops* the bone seems to be actually double when seen in section on the anterior end of the specimen. As a contribution to our knowledge on this subject I have examined skulls of three Gorgonopsians from different zones, viz. *Galesuchus gracilis* from the *Pareiasaurus* zone, a snout of *Gorgonops* sp. (S.A.M. Cat. No. 3038) from the *Endothiodon* zone of Beaufort West, and *Scymnognathus serratidens* from the *Cistecephalus* zone of Dunedin, Beaufort West. All these skulls show a cross-section through the vomer. The bone is fairly similar in all three cases with regard to the ventral surface, but the dorsal surface shows some variation, best seen and understood by reference to the figures.

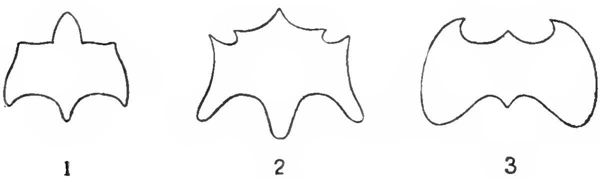


Fig. 11.

1. Cross-section through vomer of *Galesuchus gracilis* through canine.
2. Cross-section through vomer of *Gorgonops* sp. immediately anterior to canine.
3. Cross-section through vomer of *Scymnognathus serratidens* through canine.

All the figures × 3.

There is seen on the dorsal surface a progressive reduction of the median ridge, and a tendency for the two grooves to become one. None of the specimens show any signs of a median suture.

The front of the palate is considerably vaulted, the plane of the premaxilla and "vomer" being above that of the palatine and maxilla, whose inner portions rise vertically at right angles to the outer portions.

The palatines approximate to each other to form the beginning of a secondary palate considerably below the primary. The palatine is a large bone passing forward almost to the back of the canine. On its posterior and inner portion it carries a few strong, well-developed teeth.

The pterygoid has a very powerful descending process, deepest at the side of the mandible, and rising to the level of the palatine where it meets its neighbour. The maximum depth of this process is 60 mm. and the distance between the two extremities 110 mm. In

front the pterygoid meets the transpalatine and palatine. Behind the descending processes is a long narrow median bar. The anterior portion of this is formed by the pterygoids in contact, but for the greater part the pterygoids seem to be separated by a thin median forward process of the basisphenoid. This process may be the parasphenoid, but no suture can be traced between it and the main body of the bone. Superiorly the pterygoid forms a thin bony plate which is not anchylosed to its neighbour, but in places is completely separated from it by matrix.

At the back of the basisphenoid are two tubera which are strong and but slightly in advance of the basioccipital condyle.

Type. Crushed skull in sandstone. (S.A.M. Cat. No. 2671.)

Locality. 1½ miles E. of Homestead, Dunedin, Nieuweveld, Beaufort West.

Horizon. Beaufort Beds. (*Cistecephalus* zone.)

3. Scymnognathus serratidens, sp. nov.

(Plate XIII., figs. 2, 4. Text-fig. 11.)

The type of this new species is the anterior two-thirds of a skull and lower jaw found 3 miles WSW. of the homestead on the farm Dunedin, Beaufort West, in a calcareous nodule. It is smaller than either *S. whaitsi* or *S. tigriceps*, and slightly smaller than *S. angusticeps*, although agreeing in general shape with the two former. It differs from *S. tigriceps*, *S. angusticeps*, and *S. minor* in having all its teeth serrated behind in their lower halves. The incisors and canines of *S. tigriceps* are worn down to a certain extent, and it is just possible that the lower parts of these teeth might have been serrated; but the molars of the larger form certainly show no trace of serration.

The premaxilla, maxilla, and septomaxilla are as in *S. tigriceps*, the septomaxilla having an anteriorly directed turbinal which divides the nares almost completely into upper and lower portions.

The dental formula for the upper jaw is *i*5 *c*1 *m*4. The first two incisors are smaller than the others; the largest are the third and fourth. The five incisors occupy a space of 38 mm. They are serrated on the posterior border. On the 3rd, which is the most perfectly preserved, the serrations begin 7 mm. below the edge of the premaxilla and continue almost, if not quite, to the point of the tooth. On the same tooth in a distance of 14 mm. there are 36 serrations. The maximum width of the 3rd incisor is 7 mm., and

its length below the edge of the bone 25 mm. The following gives the length of the incisors: *i*1, 19 mm.; *i*2, 21 mm.; *i*3 25 mm.; *i*4, 24 mm.; *i*5, 20 mm. In section the teeth are oval. There is a diastema of 21 mm. between the last incisor and the canine. The canine is very long, reaching almost to the bottom of the mentum, 55 mm. below the edge of the maxilla, pointed and backwardly curved. It is serrated behind in its lower half. Behind is a diastema of 15 mm., and then come four molars occupying a space of 24 mm. These are simple, pointed teeth, serrated posteriorly in their lower halves. The first molar has 14 serrations in a distance of 4 mm., the whole length of the crown being 10 mm. All the teeth are implanted in very deep, distinct sockets.

The prefrontal forms the upper and anterior quadrant of the orbital border. The frontal is 85 mm. long, and just forms part of the orbital border, being almost shut out from it by the prefrontal and postfrontal. The relation of the frontal to the orbital margin in this genus is a variable one. In *S. angusticeps* the frontal forms a considerable part of the margin; in this species it is almost excluded from it; while in *S. tigriceps* and *S. whaitsi* it is very doubtful whether it plays any part in the border at all. In *Galesuchus* and *Gorgonognathus* the frontal forms but a small part of the border, while in *Scylacops* it is completely excluded by the junction of prefrontal and postfrontal.

The median preparietal is bounded by the frontals and parietals, with which it articulates by interdigitating sutures. It is oval in shape, 30 mm. long and 17 mm. broad, and is situated at the level of the postorbital bar. The pineal foramen is large and lies 5 mm. behind the preparietal.

The hinder part of the cheek below and in front of the orbit is very much hollowed out. The slope from the front of the orbit is very abrupt, while that from the maxilla is much more gentle. This concavity is much more pronounced than in *S. tigriceps*.

The nasals are long, but not convex, sloping upwards from the face to form a prominent sharp median ridge which extends back as far as the frontals.

The lower jaw has the mentum relatively less deep than that of *S. tigriceps*, and a backward slope so that the point of the jaw comes directly below the canine.

The chief features of the species are its comparatively small size, the possession of serrated teeth, of a ridge on the top of the snout, and the pronounced backward slope of the front of the lower jaw.

The following are the chief measurements of the type :—

Tip of snout to front of orbit	132 mm.
Tip of snout to back of orbit	177 ,,
Interorbital width	66 ,,
Intertemporal width	64 ,,
Depth—snout to mentum	130 ,,

Type. Incomplete skull. (S.A.M. Cat. No. 2672.)
Locality. Dunedin, Nieuweveld, Beaufort West.
Horizon. Beaufort Beds. (*Cistecephalus* zone.)

8. *On a Skull of the Genus* Kannemeyeria.

(Text-figs. 12–14.)

The genus *Kannemeyeria* was founded by Seeley in 1908 (Rep. Brit. Ass., 1908, p. 713) on a skull of a large Anomodont found by Dr. Kannemeyer near Burghersdorp, which is—according to Watson (Ann. Mag. Nat. Hist., 1912, x., p. 575)—an imperfect skull of *Dicynodon simocephalus*, Weithofer. Weithofer described his species in 1888 (Ann. K.K. Natur. Hof Mus., Wien, Bd. iii.) and figured the type, an imperfect skull. Broom (Bull. Amer. Mus., 1913) refers to this species as *Kannemeyeria simocephalus*.

The genus is characterized by having a broad frontal region, a narrow and high parietal crest, a parietal region inclined at an oblique angle to the frontal plane, the pineal foramen at the front of the parietal crest situated in a well-marked depression, an absence of the postfrontal and probably of the preparietal bones.

The hitherto described species are two :—

Kannemeyeria simocephalus (Weithofer), (*loc. cit.*),

Kannemeyeria latifrons (Broom),

and to these I now add a third, founded upon a well-preserved and complete skull together with most of the lower jaw and the first 20 vertebrae found by Mr. E. W. Pocock at Winnaarsbaaken, Burghersdorp, in 1914 (S.A.M. Cat. No. 3017), to which I propose to give the name *Kannemeyeria erithrea*, sp. nov.

Skull.—The general shape of the skull can best be understood from the figures. The orbits look almost entirely outwards. The temporal fossae are large. The nostrils are near the front of the skull. The snout is rugose—as are the supraorbital borders and the nasal overhang—and is provided with a pronounced median ridge which extends back to the plane of the front of the orbit. From the posterior point to the plane of the back of the nostril this ridge has a median groove, so that it has the appearance of being double.

The nostril is large, reniform in shape, and near the front of the snout. It has a large, overhanging bony roof. The anterior border

is formed by the premaxilla, which has a median septum separating the two nostrils. From above only the front part of the nostril can be seen. The posterior half is overhung by the nasal, which is nearly twice as wide as the premaxilla. The premaxilla has a long posterior process separating the two nasals, which, although large

Fig 12.—Top view of skull of *Kannemeyeria erithrea*. × $\frac{1}{5}$ nearly.

bones, only meet one another for a distance of about 40 mm. posteriorly.

The floor of the nostril is formed by the maxilla. This carries a large tusk, which is directed strongly forwards. Posteriorly the maxilla sends back a long process outside and below the jugal reaching to the postorbital bar. The bones in the nostril are slightly crushed, and I am unable to distinguish a separate septomaxilla. If present, it is small and certainly does not occur on the face.

The limits of the lachrymal and prefrontal are not well displayed in either of the two skulls we possess; the lachrymal is certainly small, but the prefrontal forms a large part of the inner orbital wall. The lachrymal foramen lies wholly within the orbit.

The frontal is broad and flat, forming the posterior half of the supraorbital border. It has a short process passing back along the side of the parietal, between that bone and the postorbital. There is no postfrontal.

The postorbital at its lower end rests on the jugal; it forms the whole of the postorbital bar and meets the parietal, forming part of the inner border of the temporal fossa.

The pineal foramen is placed in a distinct depression. I am inclined to believe that it is wholly surrounded by the parietals, the preparietal being absent.

FIG. 13.—Side view of skull of *Kannemeyeria erithrea*. × $\frac{1}{6}$ nearly.

The parietal crest is high and narrow. Posteriorly the parietals are separated by a deep groove which has a shallow prolongation on to the upper half of the occipital plate.

The occipital plate is peculiar. The lower two-thirds is vertical; but the interparietal and the upper halves of the squamosal parts are bent at an angle of between 110° and 120°, so that the plate is completely hidden from view both from above and from the sides. The bones of the occiput occupy the same relative positions as in other members of the Anomodontia. The foramen magnum is large. The exoccipital has, on the inner border midway between the condyle and the supraoccipital, a prominent protuberance, and external to that another smaller rugose knob; the posterior corner of the paroccipital is prolonged to form a bluntly pointed process. The lateral occipital foramen is large, lying mostly in the exoccipital,

the supraoccipital forming only a minute portion of its upper border, and the squamosal its outer border only. The condyle is tripartite.

The squamosal is a very large bone. The skull is peculiar in that the width between the outer edges of the descending processes of the squamosal is its greatest width.

Lying in the hollowed portion of the exoccipital just outside the condyle is a small rounded foramen for the exit of the 9th, 10th, 11th, and 12th nerves.

No sutures are distinguishable between the basisphenoid, exoccipital, and quadrate, and no separate quadrato-jugal can be seen.

The basioccipital forms the lower part of the tripartite condyle, narrows somewhat in front and then widens, forming on either side a large process with an outer concave articular surface, each pierced by the fenestra ovalis. The stapes is absent. The basisphenoid lies in front of the basioccipital and forms part of the anterior surface of the basioccipital process. The centre of the bone is hollowed out, and on the inner sides of the ridges bounding this hollow are the carotid foramina. Laterally and anteriorly the basisphenoid articulates with the pterygoid.

The pterygoid is a long narrow bone passing from the maxilla to the quadrate. It lies on the outer side of the palatine. For a short distance in front of the basisphenoid the two pterygoids unite in the median line. In front of this median pterygoidal plate, between it and the forked posterior end of the vomer is a large pterygoidal foramen. There is the usual posterior lateral process passing to the front of the quadrate. The sphenoidal portion of the pterygoid is very small.

The lower part of the columella cranii is seen, closely affixed to the outer side of the pterygoid and basisphenoid.

The posterior nares are large. The outer border is formed almost wholly by the palatine, which passes along the inside of the pterygoid and meets the "vomer" posteriorly. Anteriorly the palatine lies above the pterygoid and has a rugose surface which meets the premaxilla. The "vomer" is a thin median bone forming the median septum between the posterior nares. Posteriorly it forks, and curves on each side outwards to meet the palatine, passing behind that bone and forming most of the hinder wall of the posterior nares. According to Broom, this bone in the Anomodonts is formed of fused prevomers and is not homologous with the mammalian vomer.

In front of this median bone there is a pronounced median ridge on the premaxilla which extends forward half the length of the bone.

At the front of the palate this ridge is replaced by a groove, on either side of which is a less well-marked ridge.

The following are the chief measurements of the skull :—

Greatest length	450 mm.
Greatest breadth	330 ,,
Minimum width of nasal overhang	65 ,,
Maximum width of nasal overhang	119 ,,
Interorbital width	141 ,,
Intertemporal width	15 ,,
Snout to front of orbit	167 ,,
Length of orbit	82 ,,
Basal length	332 ,,
Minimum width across pterygoids	64 ,,

Lower jaw.—The most recent descriptions of the Anomodont lower jaw have been given by Watson and van Hoepen. The former gives a general account, basing his description of the bones of the back of the jaw on a "fragmentary jaw of *Kannemeyeria* collected by the author at Winnaarsbaaken, Burghersdorp District" —from which farm this type also comes. In general the jaw agrees with that figured by Watson except that, owing to the difficulty of development, it is impossible to be sure of the presence of the coronoid. Van Hoepen states expressly that a coronoid does not exist either in *Lystrosaurus* or in *Dicynodon* ; but he seems certainly to have misunderstood the position of the coronoid as defined by Watson.

The front of the jaw projects slightly upwards, forming a beak which fits into the concave upper jaw. The front of the mandible has a median ridge running from the point to the mentum bounded by two lateral grooves, one on either side, on the outer side of each of which is a less well-defined ridge.

The dentary forms almost the whole of the front of the outer surface. Its edentulous border is provided with a longitudinal groove which narrows and deepens posteriorly. The posterior part of the bone is produced into two processes, the upper of which seems to lie outside the surangular and angular. Between it and the lower process is a deep notch. The lower process lies outside the angular.

In the side view the splenial is only just seen. It forms part of the median symphysis and passes inside the angular, whose thin anterior end lies between the dentary and the splenial.

On the right-hand side of the jaw lying in the groove in the dentary is a small piece of a bone which may be the displaced coronoid.

The suture between the surangular and articular is not seen; but those between the angular and surangular and angular and pre-articular are well displayed. The surangular forms most of the upper border of the fossa, and lies within the dentary and angular. Its upper edge forms a thickened ridge. The inner flange of the articular is very pronounced.

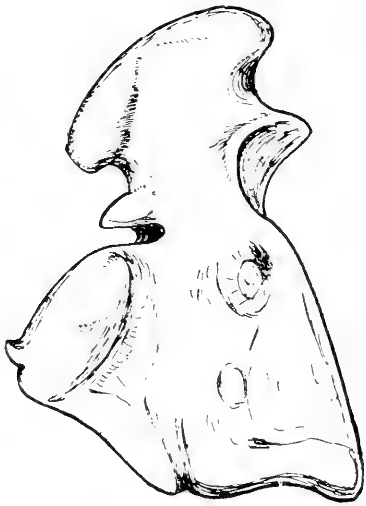


FIG. 14.—Sketch of odontoid and axis of *Kannemeyeria erithrea*. $\times \frac{1}{2}$.

Vertebrae.—Associated with the skull and lower jaw were a number of vertebrae, which seem to form a continuous series of 20 vertebrae from the odontoid backwards.

The odontoid is the only portion of the atlas preserved. It is of the usual trefoil shape with a height of 65 mm. and a maximum width of 62 mm. Its anterior face is strongly convex. In the centre of the front face is a small aperture which coincided with the small pit at the end of the occipital condyle. The upper surface is strongly concave for the floor of the neural canal. There is no intercentrum between the odontoid and the axis. The atlantal arch is not preserved. It rested, apparently, almost wholly on the odontoid, and articulated behind with the axial prezygapophyses and in front, probably, with the processes of the exoccipitals seen on either side the foramen magnum.

The axis and odontoid seem to be fused together; possibly the fusion may not be a true anchylosis, but due to the pressure of one against the other.

The axis has an elongated neural spine, compressed in the middle and swollen at either end, with a convex upper edge. The transverse processes are fairly short, and a short distance behind the front of the centrum and below the median line is a vertically elongated facet for the articulation of the capitulum of the double-headed axial rib.

The 3rd to 7th vertebrae—probably all caudals—are cemented together by matrix. The centra gradually enlarge, the flattened neural spines rapidly increase in size, as do the transverse processes, the facets for the articulation of the tubercula of the ribs becoming markedly oblong in shape. The central facets remain on the anterior edges of the centra.

The remaining vertebrae were mostly isolated in the matrix, but they seem to form a series. The neural spines from the 9th bend backwards and gradually decrease in size. The neurocentral suture becomes well marked, and the transverse and central facets are connected by an oblique groove.

The following are the chief measurements:—

	Vertebrae No.								
	Axis	3	4	5	6	7	8	13?	17?
Length of centrum	42	37	38	39	39	39	36	35	35
Width of centrum	56	55	51	62	60	59	61	50	55
Total height	128	142	161	?	195	189	170	132	143
Height of spine above transverse process	66	71	80	?	109	101	78	53	58
Width across transverse process	90	97	100	100	96	97	98	83	75
Width across prezygapophyses	55	37	42	38	43	41	42	32	39
Width across postzygapophyses	32	35	30	48	38	35	27	32	32

[All the measurements are in mm.]

Type. Skull and lower jaw. (S.A. Mus. Cat. No. 3017.)
Locality. Winnaarsbaaken, Albert, Cape Colony.
Horizon. Burghersdorp Beds. (*Cynognathus* zone.)

9. *A New Thecodont from the Stormberg Beds.*

SPHENOSUCHUS ACUTUS, g. et sp. nov.

(Text-figs. 15–17.)

This exceedingly interesting new form is described from a specimen collected by Dr. A. L. du Toit from the Red Beds of Paballon, Mount Fletcher. It consists of an incomplete and somewhat crushed skull, with the cervical vertebrae attached, the two

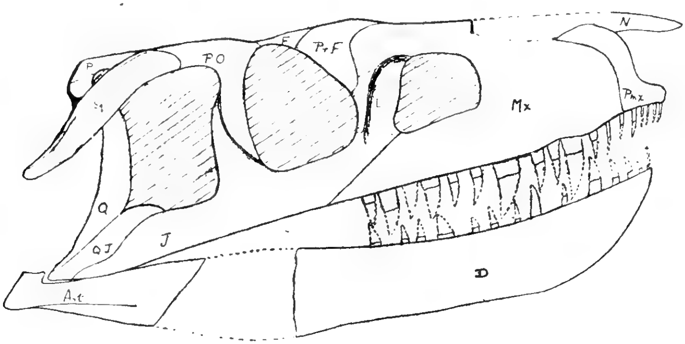


FIG. 15.—Side view of skull of *Sphenosuchus acutus*. × ½. (Slightly restored.)

scapulae, two clavicles, an interclavicle, two humeri, and some other fragmentary bones—all in one slab of rock; and a complete tibia and the distal third of a fibula which in all probability belong to the same animal.

The skull is somewhat crushed but nearly whole, and shows all the external details. It is larger than that of *Euparkeria*, and is comparatively more pointed, longer, and narrower. The orbits are rounded, and wholly in the posterior half of the skull. The supratemporal fossa is elongate, oval in shape, and larger than that of *Euparkeria* or *Ornithosuchus*. The shape of the infratemporal fossa is characteristic in that its anterior border, formed by the

jugal and postorbital, passes upwards and forwards instead of upwards and backwards as in *Euparkeria* and *Ornithosuchus*; so that the superior length of the opening is about equal to the inferior length.

The snout is characterized by the fact that the premaxilla does not form an anterior border to the nostrils, these being quite

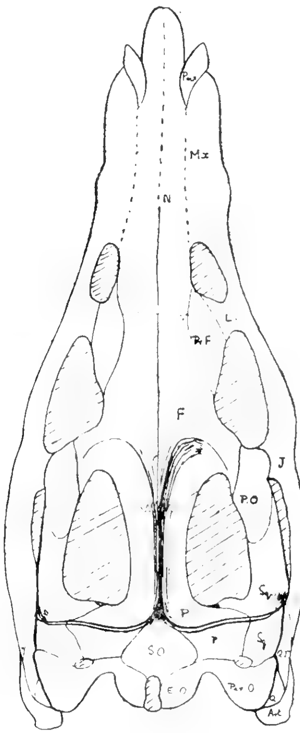


Fig. 16.—Top view of skull of *Sphenosuchus acutus*. × ½.
(Slightly restored.)

terminal. Further, there is no trace of a median suture dividing them. The roof of the snout is formed by the paired nasals, which are broken posteriorly. The extreme tip of the left nasal is missing, but the bones were obviously pointed in front. The whole of the posterior and lower borders of the nostril are formed by the premaxilla, which sends back a process separating the forward portion of the maxilla from the nasal. The nostril seems to have had an upper prolongation between the nasal and premaxilla. The premaxilla carries apparently three or four simple pointed teeth. In

Ornithosuchus and *Erpetosuchus* the premaxilla is entire, and forms an anterior border to the external nares, and Broom has considered that the bone in *Euparkeria* was similar. Of the fact that in this type the nostril was terminal and open I think there can be no doubt. Dr. du Toit, who partially developed the front of the snout before the fossil came into my hands, informs me that no bone was broken away save a tiny fragment from the outer edge of the left nasal; and in the specimen as it is now displayed there is no sign of any anterior vertical portion of the premaxilla.

There is no septomaxillary present on the face.

The antorbital vacuity is large, and is sunken in the face, having borders which make an oblique angle with the sides of the face. The whole of the lower and anterior borders is formed by the maxilla, which extends back only so far as the front of the orbit—not nearly so far as in *Euparkeria*. The maxilla carried about 12 teeth, of which 8 are preserved on the right side. Unfortunately, not one possesses the crown; but a small tooth in the lower jaw shows serrations on the anterior border similar to those of the carnivorous Dinosaurs. The teeth are flattened laterally, and vary considerably in size. The first maxillary tooth has an antero-posterior diameter of just over 1 mm.; the probable 6th, which is the largest, has a diameter at the gum of 7·5 mm. The teeth do not increase or decrease regularly in size from front to back of the jaw, but are variable.

The surface of the maxilla is plentifully supplied with grooves and small foramina for blood-vessels.

The nasal is an extremely long bone forming the upper surface of the skull from the tip of the snout nearly to the plane of the front of the orbit. It forms none of the posterior border of the nostril. The greatest width across the pair of bones is 20 mm.—at the back—while the length is about 88 mm.

The lachrymal forms the whole of the upper border and most of the posterior border of the antorbital vacuity, besides forming the larger part of the anterior orbital border.

The prefrontal is a small bone lying between the frontal, nasal, and lachrymal. Below it has a lobe-like extension articulating with the lachrymal, so that it forms about 18 mm. of the orbital border; but its width throughout most of its length is only about 6 mm.

I can see no evidence of a postfrontal. Even if one be present, the frontal is still peculiar in that it passes back to form part of the anterior border of the upper temporal fossa, separating the post-orbital from the parietal. The interorbital region has a median

elevation, broadened at the level of the postorbital bars, and narrowing posteriorly until it forms the median parietal crest. On each side there is a slight supraorbital crest; and between this and the median ridge is a well-defined channel. The frontal forms half of the supraorbital border. Its greatest length is in the middle line, the sutures with the parietals passing well forward from a point one-third along the parietal crest nearly to the anterior extremity of the supratemporal fossa.

The postorbital bar differs from that in *Euparkeria* and the allied Thecodonts in that its upper end is in advance of the lower. The descending portion of the postorbital is thus inclined backwards instead of forwards, lying in front of the ascending process of the jugal. The postorbital forms most of the outer border of the upper temporal fossa, and a small portion of the upper border of the lower opening, anteriorly articulating with the frontal, and posteriorly overlying a portion of the squamosal. Nowhere does it meet the parietal.

The jugal is a tripartite bone. Its anterior process forms the inferior border of the orbit, and articulates with the lachrymal and maxilla. It does not pass up as far in front of the orbit as in *Euparkeria*. The ascending process lies behind and superiorly interior to the postorbital and is inclined slightly forwards. The posterior process forms most of the zygomatic arch, lying outside the quadrato-jugal.

From the fact that the postorbital bar slopes in almost a parallel direction to the quadrate, the lower temporal opening has a rhomboidal shape, being bounded by the postorbital, jugal, quadrato-jugal, quadrate, and squamosal. It is slightly bigger than the upper opening. In this it agrees with *Euparkeria*, *Ornithosuchus*, and the Theropodous Dinosaurs, and differs from *Erpetosuchus*. In the relation between the sizes of the temporal openings, and in the shape of the lower opening, this form is sharply marked off from its nearest allies. Moreover, in both *Euparkeria* and *Ornithosuchus* the quadrato-jugal is a fair-sized bone whose articulation with the jugal passes downwards and forwards, and which passes up in front of the quadrate to meet the squamosal. In this form, however, the quadrato-jugal is a comparatively small flat bone which lies in the lower posterior corner of the fossa, and whose articulation with the jugal passes downwards and backwards. It lies under the jugal and overlaps part of the quadrate. There is no foramen between it and the quadrate.

The quadrate is a long, strongly developed, fixed bone with a

somewhat expanded lower end. Its upper end is fixed between the squamosal and the opisthotic. The external surface shows a well-marked longitudinal depression at the lower end of the upper half. The front edge of the bone is thin, the posterior border well rounded.

The squamosal is a strong bone, articulating with the postorbital, quadrate, parietal, opisthotic, paroccipital, and exoccipital. It forms the outer posterior corner of the skull, *i.e.* half the outer and posterior borders of the supratemporal fossa. It passes over on to the occipital plate, and takes part in the border of the lateral occipital foramen. The articulation between the squamosal and the opisthotic is pierced by a large oval foramen.

The parietal has a strong median crest which divides posteriorly and forms there the upper border of the occipital plate. The bone passes over this lateral crest and forms part of the occipital plate, articulating with the supraoccipital and squamosal, and taking part in the border of the lateral foramen. Anteriorly the bone articulates with the frontal, laterally with the squamosal, and below with the opisthotic and alisphenoid. As in *Ornithosuchus* there is no interparietal.

The occipital plate is fairly small, and consists of the supra-, ex-, and basi-occipitals, parietal, and squamosals. The supraoccipital forms the upper median portion of the plate and enters into the upper edge of the foramen magnum. The paroccipital forms no part of the border of the foramen magnum. Its outer corner is bent almost horizontally and rests on the posterior prolongation of the squamosal, with which bone it has a long curved articulation. The basioccipital is small, but it seems to form most of the incomplete condyle. The opening for the 12th nerve is in the exoccipital about 2 mm. from the lateral border of the foramen magnum.

The palate is incomplete. The anterior prolongations of the pterygoids are long, and there is a well-defined median groove. The internal nares are not seen; but they must have been considerably in advance of the postpalatal vacuities. In both these features this form agrees with the features displayed by *Erpetosuchus* and *Proterosuchus*—two forms which von Huene groups together as the *Proterosuchia*, and differs from *Ornithosuchus* and the Phytosaurs. The palatine has a long articulation with the pterygoid and forms the inner and anterior borders of the post-palatal vacuity, while its outer border, and probably the posterior, is formed by the transpalatine. The transpalatine has a suture with the jugal on its outer side.

The lower jaw is incomplete. About 100 mm. of the right ramus is anchylosed to the anterior 40 mm. of the left ramus, while a small portion of the back of the jaw is attached to the left quadrate. I am thus unfortunately unable to say whether or not a fossa was present.

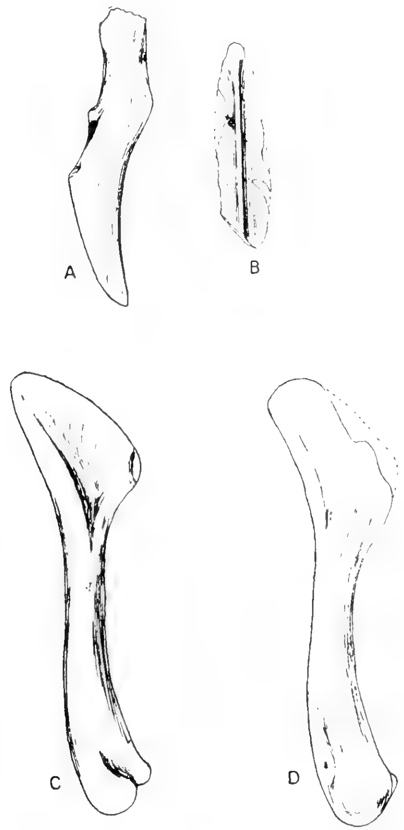


Fig. 17.—*Sphenosuchus acutus.*

A. Outer view of right clavicle.
B. Inner view of interclavicle.
C. Inner view of left humerus.
D. Outer view of right humerus.
All figures × $\frac{1}{2}$.

Remnants of 12 teeth are preserved on the right dentary, and of 5 or 6 on the left. Of these latter the 4th is small and nearly complete. It shows that the teeth were flattened, pointed, and simple, provided with serrations on the anterior border. The

dentary forms the whole of the anterior half of the outer surface and thickens in front to meet its neighbour over the whole of the symphysis. The splenial forms a large part of the inner surface of the anterior half of the jaw, but takes no part in the symphysis. It has a straight articulation with the dentary along the lower border of the jaw. The fractured end shows a small portion of the angular lying within the splenial and dentary. There is a postarticular process passing behind the extremity of the quadrate.

The anterior caudal vertebrae have been displaced and the centra are missing. The elements of the atlas cannot be distinguished, although a small curved bone lying on the right exoccipital is probably a part of the pro-atlas. The dorsal spine of the axis is present. It is 30 mm. long, higher in front than behind, and overlaps the 3rd cervical. This latter shows well-developed, strong anterior zygapophyses, shorter postzygapophyses, a straight flattened dorsal spine, and a well-marked neural canal. The dorsal spines of the 4th and 5th cervicals are also present. They are like that of the third cervical, slightly expanded at the crest, with a shallow groove running down the posterior border. The anterior ribs are double-headed.

Both scapulae, both clavicles, and an interclavicle are present, as well as both humeri.

The scapula is 81 mm. long and expanded both at its proximal and distal ends. The width of the distal end is 43 mm., of the proximal end 40 mm., while the narrowest part of the shaft—which occurs just above the proximal expansion—measures but 15 mm. in width. There is no acromion process.

The clavicles are comparatively large, thin bones, whose shape can best be understood from the figure. They have a length of 77 mm., and a mean width of about 12 mm.

The interclavicle is a small narrow elongate bone with a very prominent median ridge running throughout its whole length on the inner side.

The humerus is 113 mm. long. The proximal end is broad and flattened. The delto-pectoral crest is about 9 mm. long. In the inner view the proximal expansion is seen to be hollowed out between the delto-pectoral crest and a well-marked ridge which runs down on the inner side from the proximal condyle, which is slightly swollen and rounded. The shaft is slightly curved, and oval in cross-section; at the narrowest part the greatest diameter of this oval has a length of 10 mm. The distal end

is but slightly expanded and shows two distinct rounded condyles, of which the inner is much the larger.

On the slab of stone which contained the humeri there is a slender bone consisting of a straight shaft with slightly expanded ends, the whole being 64 mm. long. The middle of the shaft has a greatest diameter of 6 mm. This is probably the radius. There are also three incomplete metacarpals in juxtaposition with one another, and a portion of what is probably the ulna.

There is also preserved a tibia and the distal third of a fibula from the same limb. The proximal end of the tibia is expanded and has a pronounced swollen condyle on the inner side. The distal end is slightly expanded, while the shaft is long and subcircular in section. The distal end is 15 mm. wide, the shaft 9 mm., and the proximal end 29 mm.

Type. Skull and part of lower jaw with bones of the shoulder girdle and fore-limb. (S.A. Mus. Cat. No. 3014.)

Locality. Paballon, Mount Fletcher, Cape Colony.

Horizon. Red Beds. (Stormberg series.)

EXPLANATION OF PLATES.

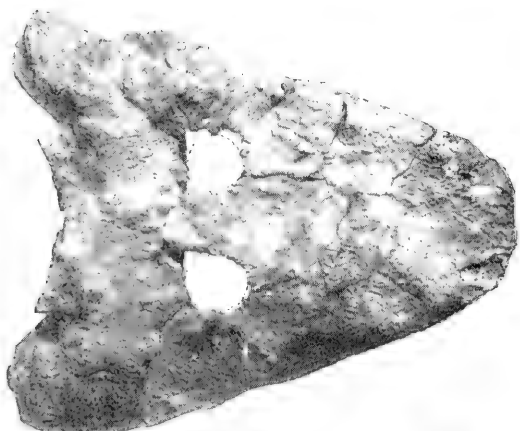
PLATE XII.

FIG.
1. Top view of skeleton of *Rhinesuchus senekalensis*. $\times \frac{1}{16}$.
2. Top view of skull of *Rhinesuchus senekalensis*. $\times \frac{1}{7}$.
3. Top view of skull of *Rhinesuchus whaitsi*. $\times \frac{2}{13}$.
4. Palatal view of skull of *Rhinesuchus whaitsi*. $\times \frac{2}{13}$.

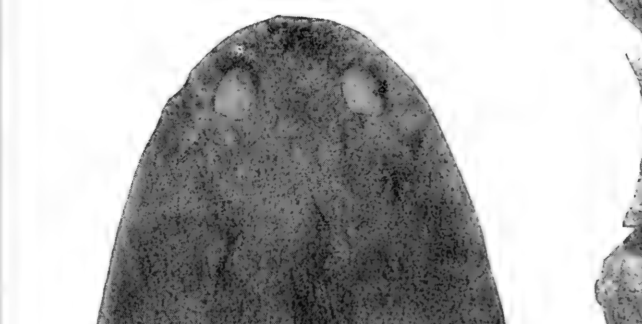
PLATE XIII.

1. Top view of skull of *Gorgonognathus longifrons*. $\times \frac{2}{7}$.
2. Top view of skull of *Scymnognathus serratidens*. $\times \frac{1}{2}$ nearly.
3. Side view of skull of *Gorgonognathus longifrons*. $\times \frac{2}{7}$.
4. Side view of skull of *Scymnognathus serratidens*. $\times \frac{1}{2}$ nearly.

1



3



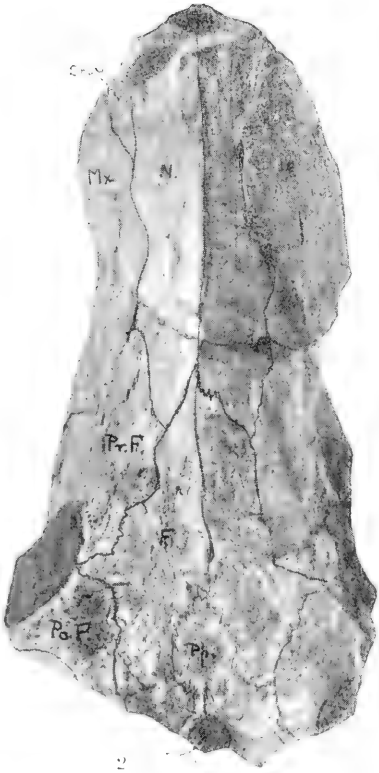
2

4

1, 2. *RHINESUCHUS SENEKALENSIS* (V. Hoepen).

3, 4. *RHINESUCHUS WHAITSI*, Broom.

1



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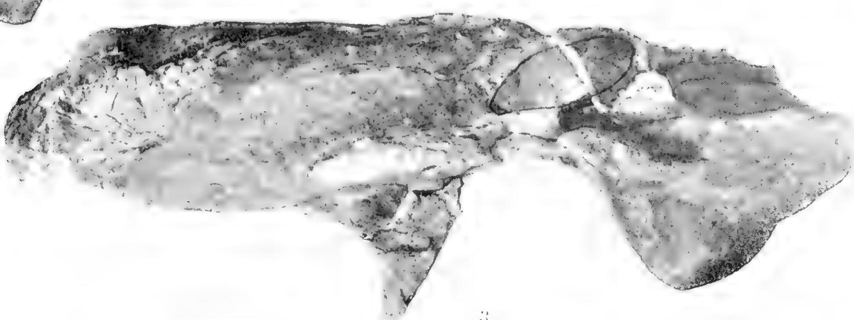

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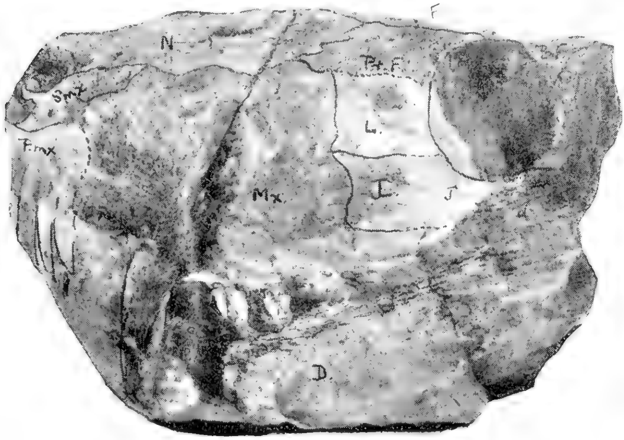


4

1, 3. *GORGONOGNATHUS LONGIFRONS*, Haughton.

2, 4. *SCYMNOGNATHUS SERRATIDENS*, Haughton.

12.—*Foraminifera and Ostracoda from the Upper Cretaceous of Need's Camp, Buffalo River, Cape Province.*—By Frederick Chapman, A.L.S., F.R.M.S., etc.

With two Plates, XIV, XV, and Text-figure.

Some little time since, I was favoured by Dr. L. Péringuey, Director of the South African Museum, with samples of fossiliferous rock from both the Upper and Lower Quarries at Need's Camp, Buffalo River, with the request that I should examine them for microzoa.

Although the material did not promise to yield a large number of the smaller organisms other than the polyzoa, after a lengthy search a small but interesting series was obtained, the results of an examination of which are now given.

LIMESTONE FROM THE UPPER QUARRY.

General Characters.—This rock is a fairly compact polyzoal limestone with a crystalline matrix (see Text-figure 18). The polyzoa forming the rock constitute about 50 per cent. of the whole, and there are a few foraminiferal tests present. These can only be examined in thin sections of the rock, owing to the compact structure of the limestone, which prevents the extraction of the small shells by fracture or pulverisation.

The following Foraminifera were met with in thin slices of this rock:

Miliolina *cf.* circularis, Bornemann sp.

Sections cut in various directions point to a comparison with this species. It is a shallow water form, and has an extensive geological range.

Miliolina *cf.* ferussacii, d'Orb. sp.

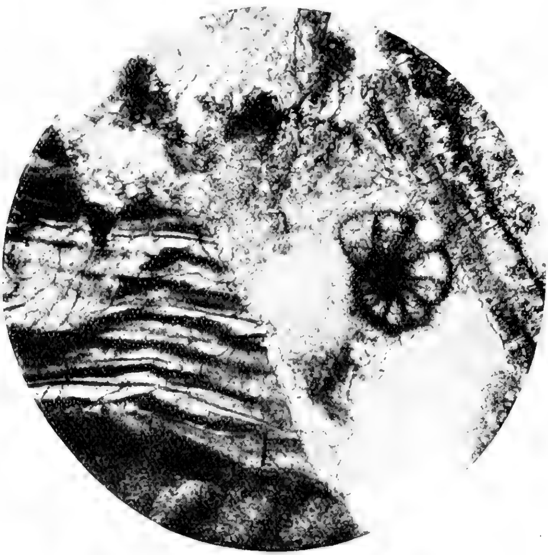
An oblique section of what appears to be the test of this or a related species occurs in the limestone. The chambers are evidently arranged on the quinqueloculine plan. Foraminifera of this type are found in all deposits ranging from the Lias to Recent.

TEXTULARIA *cf.* GRAMEN, d'Orbigny.

The test is thin, arenaceous, and the septa alternate and strongly arched. The aboral end shows no tendency towards the spiral arrangement as in *Spiroplecta*, so that the above reference to d'Orbigny's textularian species seems most applicable. A widely distributed form.

Cf. ANOMALINA sp.

A thin-walled shell in median section of a form common in shallow water sands of Cretaceous and Tertiary times (see Text-figure 18).



F. C. Photo.

FIG. 18.—Thin slice of limestone from the Upper Quarry, Need's Camp, Buffalo River, showing fine-grained calcitic matrix with Polyzoa and Foraminifera (*cf.* Anomalina sp.). × 28 diameters.

PULVINULINA sp. (of the *P. elegans* group).

Vertical and tangential sections. The test shows redundant shell-growth, as in some Cretaceous forms.

THE MICROZOA FROM THE LIMESTONE OF THE NEED'S CAMP LOWER QUARRY.

General Characters of the Rock.—The rock from this locality is a white, friable limestone, almost chalky in parts. Amongst the finer crushings of the rubble occasional specimens of foraminifera may be

detected. Their tests are, in many cases, badly corroded, but a sufficient number of specimens could be secured to obtain the diagnostic characters for the determination of the species.

FORAMINIFERA.

Family LITUOLIDAE.

Genus HAPLOPHRAGMIUM, Reuss.

Haplophragmium neocomianum, Chapman.

(Plate XIV, fig. 1.)

Haplophragmium neocomianum, Chapman, 1894, Quart. Journ. Geol. Soc., vol. l, p. 695, pl. xxxiv, figs. 2*a*, *b*.

Idem, 1904, Annals S. African Mus., vol. iv, pt. v, p. 223; pl. xxix, fig. 1.

One well-defined specimen occurs in the limestone from Need's Camp. It has been previously recorded from the Rhaetic, Aptian, and Cretaceous beds of Europe, and more recently from the Cretaceous of Pondoland.

Family TEXTULARIIDAE.

Genus SPIROPLECTA, Ehrenberg.

Spiroplecta anceps, Reuss sp.

(Plate XIV, figs. 3, 4.)

Textularia anceps, Reuss, 1845, Verstein. d. böhm. Kreideform., vol. i, p. 39, pl. viii, fig. 79; pl. xiii, fig. 2.

Idem, 1860, Sitz. d. k. Akad. Wiss. Wien, vol. xl, p. 234, pl. xiii, figs. 2*a*, *b*.

Spiroplecta anceps, Rss. sp., Chapman, 1892, Journ. R. Micr. Soc., p. 751, pl. xi, fig. 6.

This species is perhaps the most abundant foraminifer in the Need's Camp limestone. It is subject to great variation. Some of the short and wide forms resemble *S. gramen*, d'Orb. sp., but for their more numerous septation. In the majority of cases the spiroplectine commencement is almost concealed, as in fig. 3; whilst in others it is partially unrolled and conspicuous, as in fig. 4.

S. anceps is a well-known Cretaceous species, occurring in the Chalk of England, Westphalia, and Bohemia, and in the Gault of Folkestone.

Spiroplecta anceps, Reuss sp., var. infracta, var. nov.

(Plate XIV, fig. 5.)

Description.—Test formed in two stages, the first with an inconspicuous spiroplectine commencement and a short textularian series, as in *S. anceps*, from which proceeds an irregularly septate and coarsely formed test with rougly dentate margins.

Total length, 1·175 mm.; length of primary test, 0·351 mm.; width of test at oral extremity, 0·675 mm.

Spiroplecta deflata, sp. nov.

(Plate XIV, fig. 2.)

Description.—The test of this species is rather irregularly constructed of arenaceous particles, but the general plan of structure can be made out, especially when moistened; it then shows the textularian series with chambers much deflated and with a rude spiral series at the aboral end of the test.

Two specimens were found, of nearly equal size. The figured specimen has a length of ·919 mm.

This species bears the same relationship to *S. praelonga*, Reuss sp.* that *Gaudryina dispansa*, Chapman † does to *G. pupoides*, d'Orb.

Family NODOSARIIDAE.

Genus NODOSARIA, Lamarck.

Nodosaria zippei, Reuss.

(Plate XIV, figs. 6, 7.)

Nodosaria zippei, Reuss, 1845, Verstein. böhm. Kreideform., pt. i, p. 25, pl. viii, figs. 1–3.

N. zippei, Rss., Chapman, 1904, Annals S. African Mus., vol. iv, pt. v, p. 226, pl. xxix, fig. 6. (For further references see that article.)

The present examples are fragmentary but show sufficient characters to justify their reference to the above species. The costation is rather close and more numerous than is generally the case with the European

* *Textularia praelonga*, Reuss. Verstein. böhm. Kreideform., vol. i, 1845, p. 39, pl. xii, fig. 14.

† Journ. Roy. Micr. Soc., 1892, p. 753, pl. xi, figs. 10*a*, *b*.

Chalk specimens; although Reuss figures one example more comparable with the present in this respect.

N. zippei is recorded from the chalk of Bohemia, Westphalia, the Upper Bavarian Alps, Maestricht, and the Isle of Rügen; also from the Gault (Albian) of France and England, and in the Cambridge Greensand (Albian in part).

Nodosaria sulcata, Nilsson.

(Plate XIV, fig. 8.)

Nodosaria sulcata, Nilsson, 1825 (1826), K. Vet. Ak. Handl., p. 341.
Idem, 1827, Petrif. Suecana, p. 8, pl. ix, figs. 1*a*, *A*, *B* (error for 19).
N. sulcata Nilsson, Hisinger, 1837, Lethaea Svecica, p. 33, pl. x, figs. 4*a*, *b*.
Reuss, 1845, Verstein. böhm. Kreideform., pt. i, p. 26, pl. xiii, fig. 17,
Idem, 1855, Zeitschr. deutsch. geol. Gesellsch., vol. vii, p. 269, pl. viii. fig. 14*b*.
Sherborn and Chapman, 1889, Journ. Roy. Micr. Soc., p. 486, pl. xi, fig. 24.
Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. ii, vol. xxi, Abth. i, p. 75, pl. viii, fig. 24.

This is a form resembling the more extensively ranging *Nodosaria obliqua*, L. sp., but with the striate-costate ornament disposed vertically instead of obliquely. It is almost essentially an Upper Chalk species, but has also been found in the Lower Tertiary (London Clay).

The Cretaceous localities for this form are the Chalk of the Paris Basin, Lemberg, Rügen, the Upper Bavarian Alps, and Bohemia.

Genus CRISTELLARIA, Lamarck.

Cristellaria parallela, Reuss.

(Plate XIV, fig. 9.)

Cristellaria parallela, Reuss, 1862 (1863), Sitzungsb. d. k. Akad. Wiss. Wien, vol. xlvi, p. 67, pl. vii, figs. 1, 2*a*, *b*.
Berthelin, 1880, Mém. Soc. Geol. France, ser. 3, vol. i, Mém. v, p. 56.
Chapman, 1894, Quart. Journ. Geol. Soc., vol. l, p. 712.
Idem, 1894, Journ. Roy. Micr. Soc., p. 647, pl. ix, figs. 5*a*, *b*.

This elongate and parallel-sided variation of the *C. crepidula* type is well known from Cretaceous strata. It has occurred in the Lower Greensand (Aptian) of Surrey, also in the Gault (Albian) of Folkestone, France and Germany.

Cristellaria intermedia, Reuss.

(Plate XV, fig. 10.)

Cristellaria intermedia, Reuss, 1845, Verstein. böhm. Kreideform., pt. i, p. 33, pl. xiii, figs. 57, 58; pt. ii, p. 108, pl. xxiv, figs. 50, 51.

Alth, 1850, Haidinger's Naturw., Abhandl. iii (ii), p. 267, pl. xiii, fig. 23.

An interesting species of the vaginuline or compressed forms of *Cristellaria*, but having acute, or even keeled, margins. This is typically a Cretaceous form, found in the Lemberg and Bohemian Chalk; variations of this species have been recorded by Reuss * from the Greensand (Cenomanian) of New Jersey, and by Deecke † from the Oxfordian of Montbeliard, France. In the former the test is inflated and the segments higher as in Reuss' *C. planiuscula*, whilst the latter has the series of chambers more closely inrolled.

Cristellaria secans, Reuss.

(Plate XV, figs. 11*a*, *b*.)

Cristellaria secans, Reuss, 1860, Sitzungsb. d. k. Ak. Wiss. Wien, vol. xl, p. 214, pl. ix, figs. 7*a*, *b*.

Cristellariae of the above type, with prominent and parallel sutural ribs, are fairly common in the washings of the limestone from the Lower Quarry, but in many cases so corroded that they can only be generally identified as probably belonging to this species. The figured specimen is a good example of Reuss' *C. secans*, which that author found in the Gault Clay of the Rhine. A variety of this species, *angulosa*, has also occurred in the Folkestone Gault.

Family ROTALIIDAE.

Genus DISCORBINA, Parker and Jones.

Discorbina pileolus, d'Orbigny sp.

(Plate XV, figs. 13*a*, *b*.)

Valvulina pileolus, d'Orbigny, 1839, Foram. Amér. Mérid., p. 47, pl. i, figs. 15–17.

Discorbina pileolus, d'Orb. sp., Parker and Jones, 1865, Phil. Trans.,

* Sitzungsb. d. k. Ak. Wiss. Wien, vol. xliv, 1861 (1862), p. 336, pl. viii, figs. 2*a*, *b*.

† Mém. Soc. d'Emulation de Montbeliard, vol. xvi, 1886, p. 30, pl. ii, figs. 19, 19*a*.

vol. clv, p. 385; Brady, 1884, Rep. Chall., vol. ix, p. 649, pl. lxxxix, figs. 2–4; Chapman, 1894, Quart. Journ. Geol. Soc., vol. l, p. 719; Idem, 1896, Journ. Roy. Micr. Soc., p. 591, pl. xiii, figs. 14*a*, *b*.

The figured specimen is practically identical with those of the Cretaceous and Neocomian in England. It is also found in Tertiary strata, and persists to the present day.

Genus TRUNCATULINA, d'Orbigny.

Truncatulina schloenbachi, Reuss sp.

(Plate XV, figs. 12*a*, *b*.)

Rosalina schloenbachi, Reuss, 1862, Sitzungsb. d. k. Ak. Wiss. Wien, vol. xlvi, Abth. i, p. 87, pl. xi, figs. 5*a*–*c*.

Discorbina schloenbachi, Reuss sp., Egger, 1899, Abhandl. k. bayer. Akad. Wiss., Cl. ii, vol. xxi, Abth. i, p. 164, pl. xviii, figs. 19–21.

Chapman, 1904, Annals S. Afr. Mus., vol. iv, pt. v, p. 229, pl. xxix, figs. 16, 16*a*.

In some respects, as in the embracing character of the last whorl of chambers on the inferior face, this species resembles a discorbine form, but as already pointed out (see this publication, 1904, p. 230), it appears naturally to belong to the genus *Truncatulina* on account of its finely perforated or smooth test. It is a typical Cretaceous form.

Truncatulina ungeriana, d'Orbigny sp.

(Plate XV, figs. 16*a*, *b*.)

Rotalina ungeriana, d'Orbigny, 1846, Foram. Foss. Vienne, p. 157, pl. viii, figs. 16–18.

Truncatulina ungeriana, d'Orb. sp., Brady, 1884, Rep. Chall. vol. ix, p. 664, pl. xciv, figs. 9*a*–*c*.

Egger, 1899, Abhandl. k. bayer. Ak. Wiss., Cl. ii, vol. xxi, Abth. p. 150, pl. xix, figs. 4–6.

Chapman, 1912, Mem. Nat. Mus. Melbourne, No. 4, p. 43, pl. vi, figs. 2*a*–*c*.

Amongst the many modifications of this species, which ranges from the Lower Cretaceous to recent deposits, the present examples agree most nearly with the figured Chalk specimens in having a thicker test and more umbonate facial aspect.

Genus ANOMALINA, Parker and Jones.

Anomalina ammonoides, Reuss sp.

(Plate XV, fig. 14.)

Rosalina ammonoides, Reuss, 1845, Verstein. böhm. Kreidef., pt. i p. 36, pl. xiii, fig. 66; pl. viii, fig. 53.

Anomalina ammonoides, Rss. sp., Perner, 1897, Foraminifery Vrstev Bělohorských (Palaeontographica Bohemiae, No. iv), p. 72.

Chapman, 1898, Journ. Roy. Micr. Soc., p. 4, pl. i, figs. 5*a–c*. (For extended synonymy see last quoted paper.)

This species has been recorded from beds as old as the Neocomian. It is one of the commonest of Cretaceous rotalines, and is found in dredgings at the present day. The specimen before us is a perfect and well-developed shell.

Genus PULVINULINA, Parker and Jones.

Pulvinulina karsteni, Reuss sp.

(Plate XV, figs. 15*a–c*.)

Rotalia karsteni, Reuss, 1855, Zeitschr. d. deutsch. geol. Gesellsch., vol. vii, p. 273, pl. ix, fig. 6.

Pulvinulina karsteni, Rss. sp., Chapman, 1892, Quart. Journ. Geol. Soc., vol. xlviii, p. 517.

Egger, 1899, Abhandl. d. k. Akad. bayer. Wiss., Cl. ii, vol. xxi, Abth. i, p. 161, pl. xx, figs. 32–34.

A very common species in the present collection from the Lower Quarry. It is characteristically an Upper Chalk form, but is also known from the Lower Cretaceous and a few Tertiary deposits. In recent seas a more biconvex variety is known from widely separated areas, both in the northern and southern hemispheres. The specimens now dealt with are most comparable with those figured by Reuss from the Upper Cretaceous of Europe.

OSTRACODA.

Family BAIRDIIDAE.

Genus BAIRDIA, McCoy.

Bairdia subdeltoidea, Münster sp.

Cythere subdeltoidea, Münster, 1830, Jahrb. für Min. etc., p. 64, No. 13; 1835, p. 446.

Cytherina subdeltoidea, Münst. sp., Römer, 1838, Jahrb. für Min. etc., p. 517, pl. vi, fig. 16.

Reuss, 1845, Verstein. böhm. Kreideform., pt. i, p. 36, pl. v, fig. 38; pt. ii, p. 104.

Bairdia subdeltoidea, Münst. sp., Rupert Jones, 1889 (1890), Mon. Cret. Entom., Suppl. (Pal. Soc.), p. 5, pl. ii, figs. 31–34.

Examples of the above species in the Need's Camp washings exactly compare with the types figured from the Cretaceous of England and North Germany. One of the species shows a deep sinus on the ventral side of the valves similar to that figured by Rupert Jones (*loc. cit.* 1890) on pl. ii, fig. 34.

B. subdeltoidea is also met with in Tertiary strata in Europe, and a near relative is the living *B. foveolata*, G. S. Brady,* from Australia, the West Indies, Crete, Serpho, Hongkong Harbour, Admiralty Islands, etc.

Bairdia subdeltoidea, Münster sp. var. aequalis, var. nov.

(Plate XV, figs. 17*a*, *b*.)

Description.—This variety is distinguished from the type form in its more ovate shape, as seen from the side of the valve; the anterior part being less broadly rounded and the posterior extremity less prolonged. It thus comes nearer to *B. amygdaloides*, G. S. Brady,† a Miocene to Recent species.

Bairdia africana, sp. nov.

(Plate XV, figs. 19*a–c*.)

Description.—Carapace ovoid or pear-shaped, moderately tumid. Valves seen from the side highest above the middle, anteriorly truncately rounded towards the dorsal margin; posteriorly tapering and sub-acuminate; ventral border widely curved and with a steep face. Edge view of carapace subovate and with a steep face, thickest about the middle. End view subcordate. Surface smooth or faintly pitted.

Dimensions.—Length, ·702 mm.; height, ·439 mm.; thickness of carapace, ·358 mm.

The nearest form to the above is the before-mentioned *B. amygdaloides*, G. S. Brady, but which differs from *B. africana* in having a more salient dorsal border.

* *B. foveolata*, G. S. Brady, Les Fonds de la Mer, vol. i, 1867, p. 56, pl. vii, figs. 4–6. Id., Rep. Chall. Zool. vol. i, pt. iii, Ostracoda, 1880, p. 55, pl. viii, figs. 8*a–f*, and figs. 2*a–f*.

† Rep. Chall. tom. cit., p. 54, pl. ix, figs. 5*a–f*; pl. x, figs. 2*a–c*.

Fam. CYTHERIDAE.

Genus CYTHERE, Müller.

Cythere postcultrata, sp. nov.

(Plate XV, figs. 18*a*, *b*.)

Description.—Valve subrhomboidal, rounded in front, tapering behind to the acuminate extremity; dorsal edge straight, ventral obliquely truncated. Surface higher at the post-ventral region, and sloping away to the front and dorsal border. Near the ventral edge in the posterior region is a keel-shaped prominence curving inwards and merging into the surface about the middle of the ventral edge of the valve. Surface relieved with a few irregularly disposed pittings.

Dimensions.—Length, ·527 mm.; height, ·3 mm.; depth of valve ·08 mm.

Relationships.—There appear to be no closely related forms, either fossil or recent, with the exception of Dr. G. S. Brady's "Challenger" species, *Cythere cytheropteroides*,* a form dredged at 150 fathoms from the Cape of Good Hope. The present species, however, is more pyriform in outline.

SUMMARY OF RESULTS.

Upper Quarry.

The meagre series of Foraminifera obtained from this locality does not afford any data which can be used to decide the age of the deposit. The genera found, viz. *Miliolina*, *Textularia*, *Anomalina*, and *Pulvinulina*, are all widely distributed at the present day, and the species, where they could be determined, denote moderately shallow water conditions. Further than this, they are components of similar faunas as far back as the Cretaceous and even earlier Mesozoic strata. In thin sections the particular types of polyzoa appear to indicate a relationship to the like fauna of the Lower Quarry.

Lower Quarry.

The following list of species of Foraminifera and Ostracoda throws a decided light on the age of this bed.

Foraminifera:

Haplophragmium neocomianum, Chapm.
Spiroplecta anceps, Reuss sp.

* Rep. Chall., vol. i, Zool., pt. iii, Ostracoda, 1880, p. 78, pl. xv, figs. 5*a*–*d*.

Spiroplecta anceps, var. *infracta*, nov.
,, *deflata*, sp. nov.
Nodosaria zippei, Reuss.
,, *sulcata*, Nilsson.
Cristellaria parallela, Reuss.
,, *intermedia*, Reuss.
,, *secans*, Reuss.
Discorbina pileolus, d'Orb. sp.
Truncatulina schloenbachi, Reuss sp.
,, *ungeriana*, d'Orb. sp.
Anomalina ammonoides, Reuss sp.
Pulvinulina karsteni, Reuss sp.

Ostracoda:
Bairdia subdeltoidea, Münster sp.
,, ,, var. *aequalis*, nov.
,, *africana*, sp. nov.
Cythere postcultrata, sp. nov.

Amongst the Foraminifera of generally Cretaceous aspect may be noted *Haplophragmium neocomianum* and *Spiroplecta anceps*. The species which lend to the deposit an Upper Cretaceous appearance are *Nodosaria zippei* (a quite restricted form), *N. sulcata* (almost invariably Upper Cretaceous), *Cristellaria parallela*, *C. intermedia*, and *C. secans*. This latter species is in exactly the condition of growth and size as found in the typical Chalk faunas of Europe, and is one of the commonest species in the limestone from Need's Camp Lower Quarry. All the rotalines, whilst having an extensive geological range, from the Cretaceous to the present time, are typical of the Upper Cretaceous also, and their present occurrence as to size and development favours the idea of their Cretaceous age.

Of the Ostracoda only one species, *Bairdia subdeltoidea*, is available for comparison, as the remainder are new forms. The examples referred to the above-named specific form (a Cretaceous and early Tertiary species) are those of typical Cretaceous valves.

EXPLANATION OF PLATES.

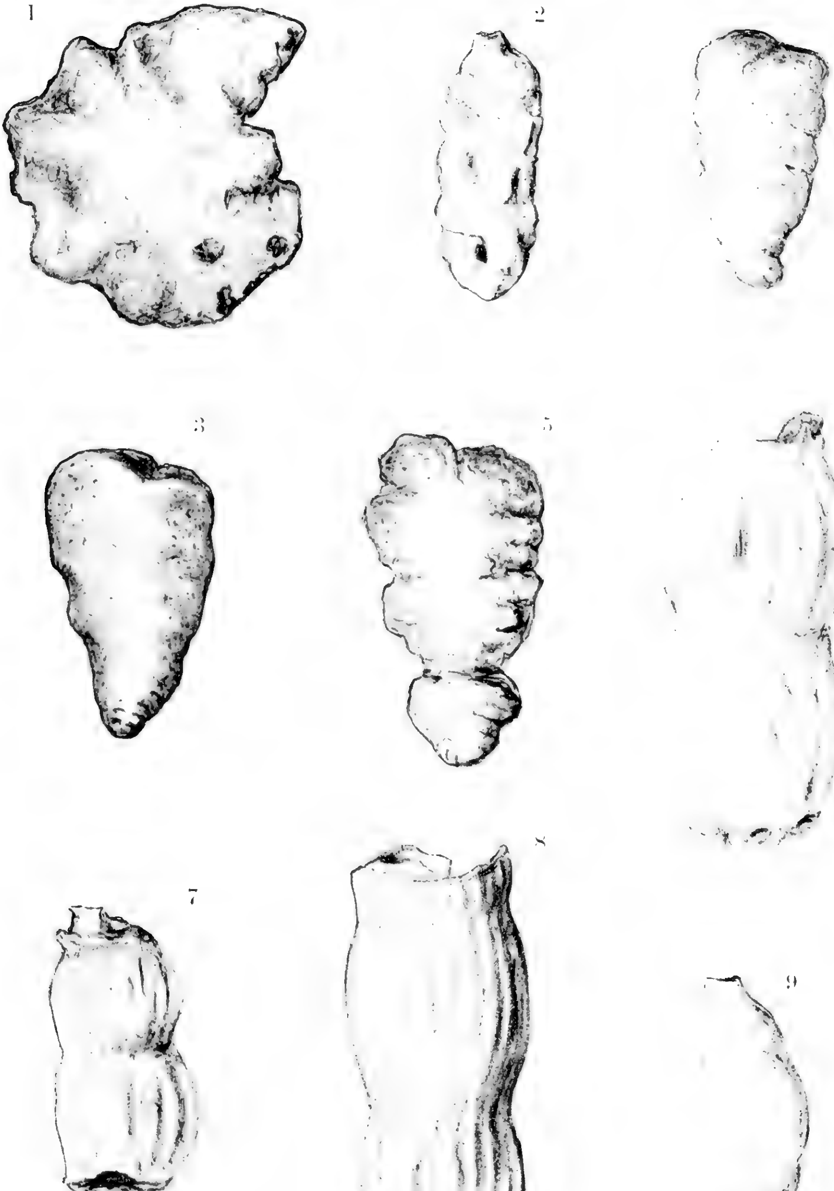
(All figures magnified 36 diameters.)

Plate XIV.

Fig. 1.—*Haplophragmium neocomianum*, Chapman.
„ 2.—*Spiroplecta deflata*, sp. nov.
„ 3.— „ *anceps*, Reuss sp.
„ 4.— „ „ „ An example with a well-developed aboral extremity.
„ 5.— „ „ „ var. *infracta*, var. nov.
„ 6.—*Nodosaria zippei*, Reuss.
„ 7.— „ „ „
„ 8.— „ *sulcata*, Nilsson.
„ 9.—*Cristellaria parallela*, Reuss.

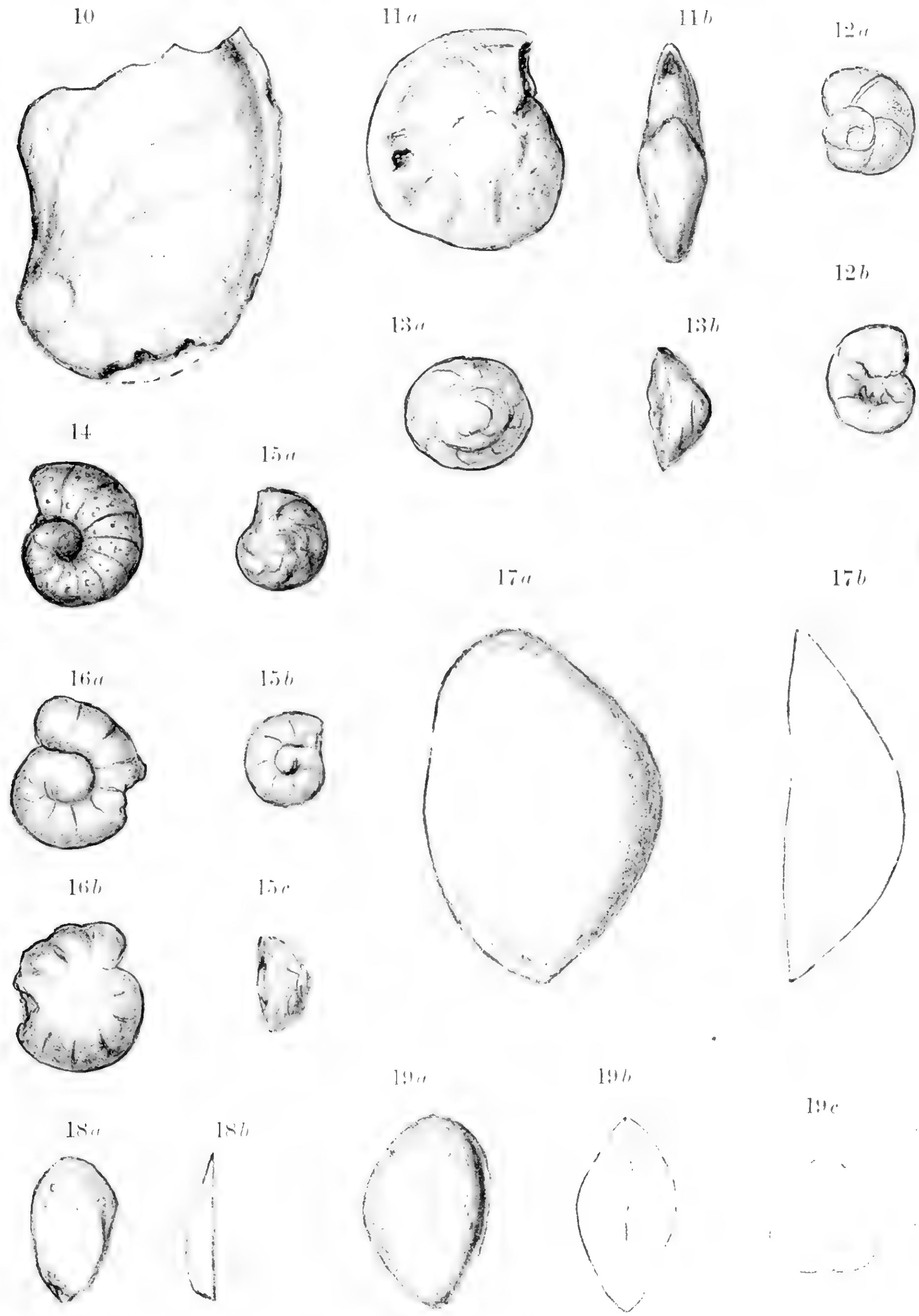
Plate XV.

Fig. 10.—*Cristellaria intermedia*, Reuss.
„ 11.— „ *secans*, Reuss: *a*, lateral aspect; *b*, oral aspect.
„ 12.—*Truncatulina schloenbachi*, Reuss sp.: *a*, superior aspect; *b*, inferior aspect.
„ 13.—*Discorbina pileolus*, d'Orb. sp.: *a*, superior aspect; *b*, inferior aspect.
„ 14.—*Anomalina ammonoides*, Reuss sp.
„ 15.—*Pulvinulina karsteni*, Reuss sp.: *a*, superior aspect; *b*, inferior aspect: *c*, peripheral aspect.
„ 16.—*Truncatulina ungeriana*, d'Orb. sp.: *a*, superior aspect; *b*, inferior aspect.
„ 17.—*Bairdia subdeltoidea*, Münster sp., var. *aequalis*, var. nov.: *a*, left valve, lateral aspect; *b*, edge view, ventral aspect.
„ 18.—*Cythere postcultrata*, sp. nov.: *a*, carapace from right side; *b*, edge view.
„ 19.—*Bairdia africana*, sp. nov.: *a*, carapace from right side; *b*, edge view, ventral aspect; *c*, end view of carapace.



Foraminifera. Need's Camp, Buffalo R.

F.C. del. Adlard & West Newman.



FORAMINIFERA: FIGS. 10–16. OSTRACODA: FIGS. 17–19. NEED'S CAMP, BUFFALO R.

F.C. del. *Adlard & West Newman.*

13.—*Some New Species of Anomodontia (Reptilia).*—By R. Broom, D.Sc., C.M.Z.S., and S. H. Haughton, B.A., F.G.S., Assistant Director.

(With 6 Text-figures.)

Genus DICYNODON, Owen.

Dicynodon corstorphinei, sp. nov.

A small skull and lower jaw collected by the Rev. J. H. Whaits at Graaff Reinet (S.A. Mus. Cat., No. 3337) seems to belong to an undescribed species, although in general appearance it partakes somewhat of the nature of *Dicynodon lutriceps.*

The most noteworthy characters are the shortness of the beak, the shape of the postfrontal, and the position of the pineal foramen. The skull is depressed. The intertemporal bar is wider than the interorbital region. The orbit is fairly large, looking more upwards than outwards. The postfrontal extends outwards along the postorbital bar somewhat in the manner seen in *Eocyclops longus.* The preparietal is long and forms the anterior border of the pineal foramen, which is very far back—half way along the fairly long parietal bar. The portions of the parietals behind the foramen are thus short and broad, overlapped for more than half their width by the postorbitals and truncated posteriorly by the interparietal. The interparietal in its upper portion has a strong median ridge. The occipital condyle is of the tripartite type.

The specimen is tuskless.

The chief measurements are:

Greatest length	160 mm.
Greatest width	ab. 150 ,,
Basal length	143 ,,
Interorbital width	25 ,,
Intertemporal width	30 ,,
Snout to front of orbit	40 ,,
Length of preparietal	21 ,,

From *Dicynodon lutriceps* this type seems to differ in having the intertemporal width greater than the interorbital, in not having the parietals so fully covered by the postorbitals, in the position of the pineal foramen, and in the size of the preparietal.

The form is also strongly reminiscent of *D. mustoi*; but the latter is somewhat more slenderly built, the pineal foramen is further forward, and the postfrontal is a much larger bone.

The chief resemblance, however, is to Owen's *Oudenodon baini*, as far as can be judged from the figure of the latter. The two agree in general shape, in the relation between the interorbital and intertemporal width, and in the position of the pineal foramen. The species

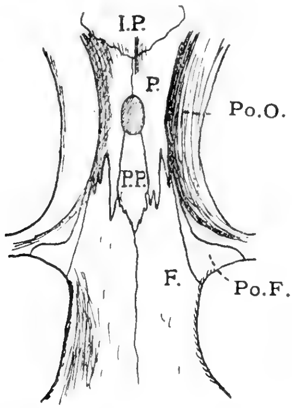


Fig. 19.—*Dicynodon corstorphinei*, Br. and Htn. Type, No. 3337. Temporal and frontal regions. × 0·7.

Oudenodon baini cannot, however, stand. In the first place, we know that *Oudenodon* is but the female of *Dicynodon*; Owen had previously described another specimen as the type of *Dicynodon baini*; and, lastly, *Dicynodon baini* is but a synonym for *D. tigriceps*.

Type.—Skull without tusks, and lower jaw (S.A. Mus. Cat., No. 3337).

Locality.—Heuning Nest Krantz, Graaff Reinet, C.P.

Horizon.—Lower Beaufort Beds, *Endothiodon* zone (?).

Dicynodon cavifrons, sp. nov.

This new species is founded on a skull from Fraserburg, C.P., collected by the late T. Bain, Esq.

The chief measurements are:

Greatest length (oblique)	215 mm.
Greatest width	ab. 200 ,,
Interorbital width	31 ,,
Intertemporal width	37 ,,
Width across nasals	42 ,,
Width between nostrils	ab. 25 ,,
Width between canines	30 ,,
Basal length	172 ,,

The orbits are triangular, their superior borders considerably shorter than the others, and lie entirely in the anterior half of the skull. The frontal is considerably hollowed out, and is narrower than the flattened parietal region. The snout is short and weak. The tusks

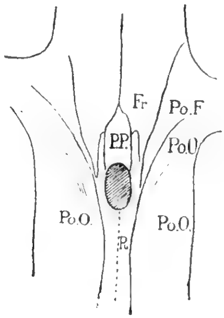


FIG. 20.—*Dicynodon cavifrons*, Br. and Htn. Type, No. 747. Preparietal region. × ½.

project downwards and are midway below the nostrils and orbits. The postorbitals are large, and almost meet in the middle line above the parietals. The postfrontal is an elongate triangular bone. The squamosal extends far back behind the occipital plate.

Type.—Skull lacking outer arches (S.A. Mus. Cat., No. 747).

Locality.—Fraserburg, C.P.

Horizon.—Lower Beaufort Beds, probably *Cistecephalus* zone.

DICYNODON ROGERSI, sp. nov.

Some years ago Dr. Rogers collected in the Thee Kloof, Nieuweveld, C.P., an almost complete skull and lower jaw which was regarded as a male specimen of *D. kolbei.* Recent examination has, however, led us to consider that it may well be taken as the type of a new species. The skull is in a good state of preservation, and shows most of the sutures of the top of the skull.

The snout is slightly longer, and the nasal bosses are not so well developed as in *D. kolbei*. The orbit is both relatively and absolutely shorter, although of similar shape. The parietal bar also differs. The ridges, instead of approximating most closely to each other in the posterior half of the bar as in *D. kolbei*, are closest at the front of the

Fig. 21.—*Dicynodon rogersi*, Br. and Htn. Type, No. 2356. × $\frac{1}{3}$.

bar and diverge gradually posteriorly. The postfrontal does not narrow so rapidly as in *D. kolbei* and consequently covers a greater area. The preparietal has its two sides parallel and not convergent posteriorly, and forms a large portion of the anterior half of the parietal foramen. The temporal fossa is long and regularly oblong in shape. The preparietal region is hollowed out.

A rare character displayed by the type is the feeble and anteriorly directed tusks. They arise directly below the nostrils.

The chief measurements of the skull are:

Greatest length (oblique)	ab. 290 mm.
Greatest width	228 ,,
Interfrontal width	50 ,,
Intertemporal width	45 ,,
Basal length	ab. 230 ,,
Width across nasals	48 ,,
Width between nostrils	28 ,,

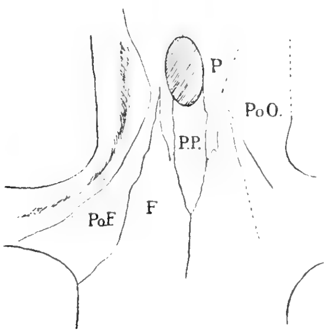


Fig. 22.—Preparietal region of same. × ½.

Type.—Skull (S. Af. Mus. Cat., No. 2356).
Locality.—Thee Kloof, Nieuweveld, C.P.
Horizon.—Lower Beaufort Beds, bottom of *Cistecephalus* zone.

Dicynodon pygmaeus, sp. nov.

This is one of the smallest known species of *Dicynodon*. As two or three specimens were obtained from the same locality of about similar size, it seems probable that the specimen represents a small species rather than a young individual.

The species is characterised by the relatively great width of the anterior ends of the parietals, which causes the preparietal region to be nearly twice as wide as the frontal.

The frontals are large, and extend well back by the sides of the preparietal. The postfrontals are very slender. The postorbitals are large, the posterior portions being broad and rather flat. The squamosals are relatively less developed than in most species.

The following are the principal measurements:

Greatest length	66 mm.
Greatest width	ab. 50 ,,
Interorbital width	11 ,,
Intertemporal width (minimum)	15 ,,

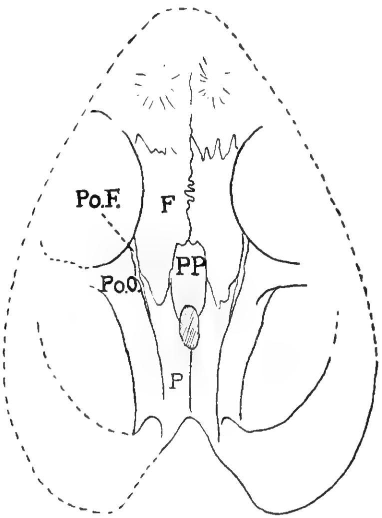


Fig. 23.—*Dicynodon pygmaeus*, Br. and Htn. Type, No. 2664. Natural size.

Type.—Female skull (S. Af. Mus. Cat., No. 2664).
Locality.—Dunedin, Beaufort West, C.P.
Horizon.—Lower Beaufort Beds, *Cistecephalus* zone.

Genus EMYDOPS, Broom.

Emydops platyceps, sp. nov.

This little skull, while representing a new species, is not sufficiently well preserved to enable us to say with perfect certainty that it belongs to the genus *Emydops*. It agrees, however, sufficiently closely with the known species of *Emydops* to admit of its being placed here at least provisionally.

There is a slender tusk which is directed downwards and forwards, and at least one slender molar tooth. The parietal region is broad and transversely concave. The relations of all the bones in the preparietal region are as in previously known species of *Emydops*, but the proportions differ considerably, as will be seen from the figure given.

The following are the principal measurements:

Greatest length	53 mm.
Greatest width	37 ,,
Interorbital width	10 ,,
Intertemporal width	15 ,,
Basal length	48 ,,
Minimum width across pterygoids . .	6 ,,
Width across palate between tusks . .	12·5 mm.

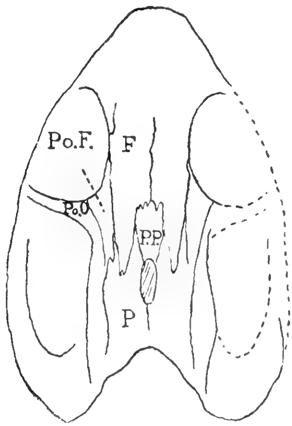


FIG. 24.—*Emydops platyceps*, Br. and Htn. Type, No. 2667. Natural size.

Type.—Skull (S. Af. Mus. Cat, No. 2667).
Locality.—Dunedin, Beaufort West, C.P.
Horizon.—Lower Beaufort Beds, *Cistecephalus* zone.

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14.—*Investigations in South African Fossil Reptiles and Amphibia* (Part 10).—By S. H. Haughton, B.A., F.G.S., *Assistant Director.*

10. *Descriptive Catalogue of the Anomodontia, with especial reference to the examples in the South African Museum* (Part 1).

(With 3 Plates and 20 Text-figures.)

This first part of the Catalogue of the Anomodontia contains forms assigned to the genus *Dicynodon* and to other genera without molar teeth allied to it, but omits *Lystrosaurus.* In view of van Hoepen's recent additions to the named species of this latter genus, a revision of the genus is necessary. The South African Museum collection contains a large number of very finely preserved *Lystrosaurus* skulls; but until further and somewhat fuller descriptions with figures are given of van Hoepen's forms from Harrismith it is deemed better to allow the revision of the genus to stand over.

The genus *Dicynodon* is an exceedingly troublesome one to work, on account of the large variety of forms which have been assigned to it, forms the types of which are now deposited in collections in widely separated parts of the world, which types are occasionally rather fragmentary and not particularly well defined. The genus, in its broad sense, ranges from the bottom to the top of the Beaufort Beds; and although certain of the described forms have been placed in other genera such as *Eocyclops, Diictodon, Kannemeyeria,* and the like, the relations between all the types are very close.

Of recent years the collection in the South African Museum has been enriched by a number of very good Anomodont skulls, mainly through the efforts of the Rev. J. H. Whaits and of the Museum collectors; and these enable us to obtain a partial survey of the sub-order, as the collection contains skulls from each zone of the Beaufort Beds. Some of them can be correlated with some degree of certainty with already-described forms. Others have characters distinguishing them from these forms and, at the risk of adding to the nomenclature

and of increasing the size of the genus, these have been given specific rank.

The question of the value of certain features as species indices is one that is not of immediate moment. The root-idea underlying descriptive work of this sort is to give an account of the variation among the Anomodont reptiles so that we may obtain, if possible, some idea of the lines upon which variation has taken place. For this purpose it is better to take notice of small variations and to give each different form a special name than to "lump" possibly different animals together under the one name. It is probable that future work may prove many of our supposedly different forms to be the same; then these new names will have to disappear. But the special features which each of them implies will remain, and the name will have served its purpose.

Moreover, another purpose is served by this division of species. A genus so prolific in individuals as was *Dicynodon* and so abundant in varieties forms a good genus for the purpose of zoning; and it may be that the few zones now known among the Beaufort Beds may be increased and more accurately defined by the use of the species of *Dicynodon.* Even now, only one or two "species" seem to pass from any one zone into the next; and it may be found that each form is confined to a comparatively small thickness of strata.

In the following pages reference is made mainly to such forms as are represented in the collection of the South African Museum, but to make the catalogue somewhat more complete the literature dealing with other described forms is given, together with a brief description of the type, culled entirely from the original papers. In the absence of facilities for seeing and studying these types—mostly now in the British Museum or in the American Museum of Natural History—or of specimens which can be assigned to them, no conclusions have been drawn as to their affinities with the forms which are more fully discussed.

Genus DICYNODON, Owen.

Dicynodon jouberti, Broom.

1905. Broom. Rec. Albany Mus., i, p. 331.

This is apparently a well-marked species, while all the specimens in the S.A.M. collection range in size between fairly narrow limits. The skull is small, with fairly large orbits and comparatively broad inter-orbital and interorbital and interfrontal regions which are roughly of

equal width. In the region of the postorbital bar the jugal is at least as deep as the radius of the orbit. There is a large preparietal forming the anterior border of the pineal foramen, but there does not appear to be a postfrontal in any of the specimens in which the sutures are displayed. If present, it must have been small.

There is no evidence of a septomaxilla, which, if present, does not appear on the face. The lachrymal is small.

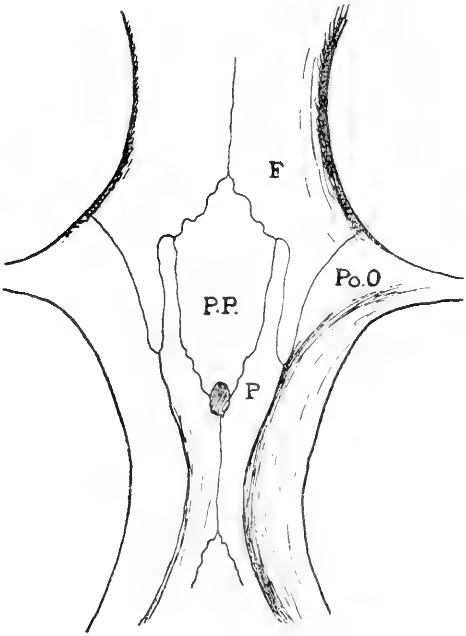

FIG. 25.—*Dicynodon jouberti*, Br. Skull No. 577. Preparietal region. Natural size.

The chief measurements of a typical skull are:

Greatest length	108 mm.
Greatest width	76 ,,
Interfrontal width	20 ,,
Intertemporal width	21 ,,
Basal length	89 ,,
Width of palate between canines	30 ,,

The basioccipital region of one specimen from the type locality (S.A.M., Cat. No. 577) has been partially displayed. The tripartite condyle is seen in section to be made up of the basioccipital and the

two exoccipitals. The foramen jugulare is bounded on the inside by the exoccipital and looks as much downwards as backwards. The basioccipital is a shallow bone and the tubera lie very little below the level of the bottom of the condyle. Between them the basioccipital has a broad and shallow groove.

Type.—Skull and lower jaw. (S.A. Mus. Cat. No. 695.)

Locality.—"The Gouph."

Horizon.—Lower Beaufort Beds. (*Tapinocephalus* zone.)

Dicynodon megalorhinus (Broom).

1904. Broom, *Oudenodon megalorhinus.* Rec. Albany Mus., i, p. 180.

The type skull is of interest as being the first Dicynodont in which a postfrontal was clearly recognised.

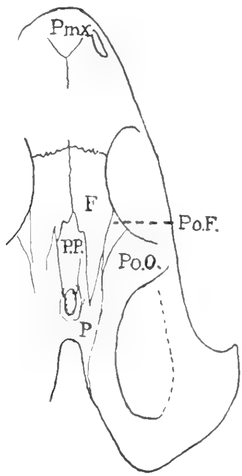

Fig. 26.—*Dicynodon megalorhinus* (Br.). Type No. 640. Natural size.

The bones of the upper part of the skull are clearly shown, and a figure is given here for the first time. Noticeable features are the long anterior extension of the parietals and the long, narrow, postfrontals.

Of the occiput and palate but little is seen. It is interesting to note, however, that the fenestra ovalis faces almost completely laterally and but very little downwards; it is rather small. The suture between the basisphenoid and basioccipital is clear. The basisphenoid, although passing back to form the anterior portion of the tuber, takes no part whatever in the border of the fenestra ovalis.

The lower border of the fenestra together with part, at least, of its anterior border is formed by the basioccipital. The posterior border is formed by the paroccipital, which also bounds the foramen jugulare. This foramen looks almost directly backwards and is placed at the level of the condyle. The carotid foramina lie together in the pit of the basisphenoid just behind the pterygoids.

Type.—Incomplete skull. (S.A. Mus. Cat. No. 640.)

Locality.—Prince Albert Road Station, C.P.

Horizon.—Lower Beaufort Beds. (*Tapinocephalus* zone.)

Dicynodon corstorphinei, Br. & Htn.

1917. Broom & Haughton. Ann. S.A. Mus., xii, 5, p. 119, fig. 19.

The occipital condyle in this species is of the tripartite type. The foramen for the exit of the IXth–XIIth nerves looks directly backwards and is on a level with the notochordal pit in the condyle. The post-temporal vacuity lies on the occipital plate just above the level of the top of the condyle.

The basisphenoid tubera lie above the level of the quadrate, so that the fenestra ovalis looks more downwards than outwards. The tubera are not greatly below the level of the condyle and the groove between them is as high as broad.

Type.—Incomplete skull and lower jaw. (S.A. Mus. Cat. No. 3337.)

Locality.—Heuning Nest Krantz, Graaff Reinet, C.P.

Horizon.—Lower Beaufort Beds. (Top (?) of *Endothiodon* zone.)

Dicynodon cyclops, sp. nov.

The specimen to be described, although somewhat reminiscent of *Dicynodon platyceps* and *D. lutriceps*, seems to differ sufficiently to be classed as a different form. It consists of a skull showing all the sutures of the top, having the following measurements :

Greatest length	225 mm.
Greatest breadth	145 ,,
Length from beak to front of orbit	52 ,,
Antero-posterior diam. of orbit	44 ,,
Interorbital width	33 ,,
Intertemporal width	34 ,,
Basal length	167 ,,

In side view the skull agrees with that of *D. pardiceps* in the concavity at the preparietal region and the convexity of the parietal

bar. The skull is considerably longer than broad. The orbits are wholly in the anterior half of the skull, are moderately large and

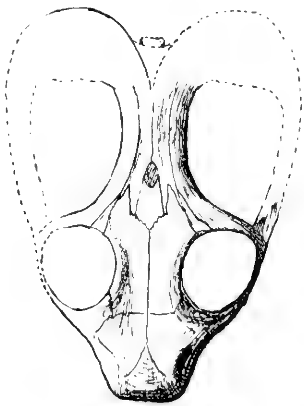

Fig. 27.—*Dicynodon cyclops*, Htn. Type. No. 3447. × ¼.

circular, and look more upwards than outwards. The snout is moderately long, and the nostrils are midway between the beak and

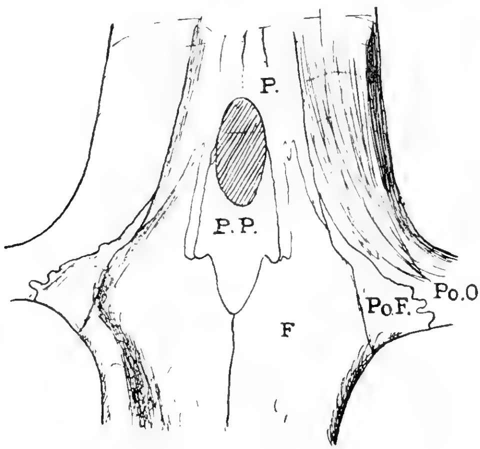

Fig. 28.—*Dicynodon cyclops*, Htn. Type. Preparietal region. Natural size.

the orbit, looking wholly laterally. The supranasal bosses are feeble, as are the caniniform processes. Between the nasal boss and the supraorbital border is a depression. The supraorbital borders are elevated so that the frontal region is concave. The postorbital bar is

slender. The parietal bar is just broader than the frontal region, and convex longitudinally. The temporal openings are large.

The premaxilla passes on to the top of the snout, separating the nasals except for a length of 15 mm., but forming no part of the upper border of the nostril.

The septomaxilla is well seen on the face. It separates the nasal from the maxilla and articulates posteriorly with both the prefrontal and the lachrymal. The lachrymal is small. The prefrontal is large and forms a large portion of the orbital border.

The arrangement of the bones around the pineal foramen is shown in the figure. The preparietal is small and forms half the border of the pineal foramen. The postfrontal is short, but fairly broad anteriorly.

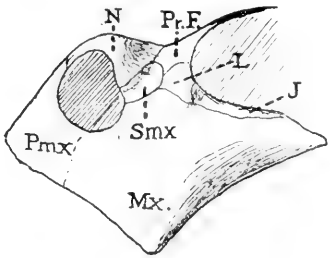

FIG. 29.—*Dicynodon cyclops*, Htn. Type. Side view of snout. × ½.

From *Dicynodon platyceps* the species differs in having the intertemporal width equal to that of the frontal region, in the small preparietal and in the detailed arrangement of the postfrontals, frontals, and parietals. From *Dicynodon lutriceps* it differs in the relation of the width of the frontal and parietal bars and in the fact that the preparietal in the earlier type is apparently wholly in front of the pineal foramen and enclosed by the frontals. No adequate figure of the arrangement of the bones in *D. lutriceps* has ever been given and I have not seen the type; so it is impossible to say here whether the two species are actually distinct.

Type.—Skull. (S.A. Mus. Cat. No. 3447.)

Locality.—Dalham, Graaff Reinet, C.P.

Horizon.—Lower Beaufort Beds. (*Endothiodon* zone.)

DICYNODON FELICEPS, Owen.

1876. Owen. Cat. Foss. Rept. S.A., p. 45; pl. xliii.

1889. Seeley. Phil. Trans. clxxx B; pl. x, fig. 3.

1890. Lydekker. Cat. Foss. Rept. & Amphib. iv, p. 20.
1913. Broom. Bull. Amer. Mus. Nat. Hist., xxxii, p. 445.
1914. Broom. Phil. Trans. B206; pl. v, figs. 50, 51.
1915. Broom. Bull. Amer. Mus. Nat. Hist., xxv, 2, p. 129.

Founded on a skull with lower jaw. Smaller than *D. lacerticeps.* Antorbital portion relatively shorter; canine curves more downwards. In older skulls orbits have distinctly triangular contour. Postorbitals meet above the parietals. Pineal foramen on a level with the middle of the temporal fossa. Ramus of mandible deeper than in *D. lacerticeps.*

Type in British Museum.

Locality.—Fort Beaufort, C.P.

Horizon.—Lower Beaufort Beds. (*Endothiodon* zone.)

DICYNODON GRACILIS (Broom).

1901. Broom, *Oudenodon gracilis.* Proc. Zool. Soc., p. 162.

The skull which forms the type of this species came from Pearston, C.P. It is rather distorted by flattening. It is a small species

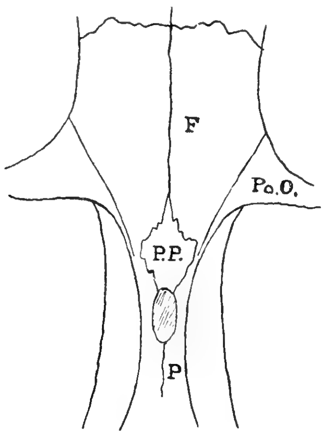

FIG. 30.—*Dicynodon gracilis* (Br.). Type. No. 590. Preparietal region. Natural size.

whose skull is relatively long and narrow. The orbits look outwards and are overhung posteriorly by a nasal boss. The cheek is fairly long. The eyes are small and are directed more outwards than upwards. The postorbital bar is halfway along the skull. The interorbital width is 25 mm., the intertemporal 18 mm. The frontal

region is flat with a well-marked median ridge. The pineal foramen is placed halfway along the parietal bar. In front of it is a narrow preparietal reaching to the level of the front of the temporal vacuity. There is no evidence of a postfrontal. The sutures are clearly marked and the postfrontal must be absent, the postorbital passing forward along the orbital border to meet the frontal.

The palate is long and narrow. The basicranial region is not well displayed; but the tubera did not extend far below the level of the occipital condyle.

The maxilla forms nearly the whole of the long and somewhat shallow cheek. The lachrymal is small as far as can be seen; the prefrontal is larger, and appears mostly on the top of the skull.

Type.—Skull. (S.A. Mus. Cat. No. 590.)

Locality.—Pearston, C.P.

Horizon.—Lower Beaufort Beds. (Probably top of *Endothiodon* zone.)

Dicynodon ictidops, Broom.

1913. Broom. Bull. Amer. Mus. Nat. Hist., xxxii, p. 446; figs. 5, 6.

A small species. Skull narrow with regularly convex upper surface. Orbits look more outwards than upwards. The nostrils are large and rounded. The tusk is small and directed downwards. The preparietal is large, postfrontal small. Frontals pass back to plane of front of pineal foramen.

A skull and lower jaw (S.A. Mus. Cat. No. 1078) were obtained at Klipfontein, Fraserburg, C.P. The sutures of the top of the skull are indeterminable, but from its general appearance the skull belongs to this species. It has been developed to show the basicranial region. The occipital condyle is large and of the tripartite type. The foramen jugulare lies at the level of the bottom of the condyle and looks downwards and backwards. The basisphenoidal tubera are large and descend considerably below the level of the condyle. The foramen ovalis looks outwards and downwards, and most of its lower border is, apparently, formed by the basioccipital. Between the two tubera there is a very deep narrow depression.

Type in American Museum of Natural History.

Locality.—Beaufort West Commonage, C.P.

Horizon.—Lower Beaufort Beds. (*Endothiodon* zone.)

Dicynodon lutriceps, Br.

1912. Broom. Proc. Zool. Soc., p. 870; pl. xcii, figs. 14–16.

Founded on an imperfect skull. Short beak; broad concave frontal region; broad flattened intertemporal region, formed almost wholly by the postorbitals. Interorbital width: intertemporal width :: 5 : 4. Supranasal ridge; small preparietal, lying entirely in front of the pineal foramen (?).

Type in the American Museum of Natural History.

Locality.—Kuil's Poort, Beaufort West, C.P.

Horizon.—Lower Beaufort Beds, 300 ft. above the level of Beaufort West.

Dicynodon pardiceps, Owen.

1876. Owen. Cat. Foss. Rept. S. Afr., p. 42; pls. xxxviii, xxxix.
1889. Seeley. Phil. Trans., clxxx B, p. 244; fig. 2.
1890. Lydekker. Cat. Foss. Rept. & Amphib., iv, p. 21.

Founded on a nearly entire skull; large, short, abruptly deflected muzzle; orbits triangular; frontals wide; parietal bar narrow; temporal fossa moderately wide; preparietal apparently fairly small.

Type in British Museum.

Locality.—Fort Beaufort, C.P.

Horizon.—Lower Beaufort Beds. (*Endothiodon* zone (?).)

Dicynodon psittacops, Br.

1912. Broom. Proc. Zool. Soc., p. 869; pl. xcii, fig. 17.
1915. Broom. Bull. Amer. Mus. Nat. Hist., xxv, 2, p. 139, fig. 28.

The type skull has the following characters: "Nostrils look almost directly upwards. Upper part of nasals thickened, and prefrontal region of orbital margin also elevated. Frontal region broad and flat. Parietal foramen situated in an elevated preparietal. Postorbitals approach each other behind the foramen and nearly touch, forming a parietal ridge. The tusk is small and directed forwards and downwards."

A specimen from Beaufort West (*Endothiodon* zone) in the South African Museum (Cat. No. 2660) almost undoubtedly belongs to this species. It consists of a skull and lower jaw in a hard nodule. The top of the skull has been cleared. The interorbital width is slightly greater than the intertemporal. The postorbitals almost meet at the back of the parietal bar. The pineal foramen is 10 mm. behind

the level of the postorbital bar. The preparietal is large, with an irregular anterior border. The postfrontals are apparently small. The chief measurements are:

Length of skull (oblique)	100 mm.
Greatest width	64 ,,
Snout to plane of orbit in median line	44 ,,
Basal length	83 ,,

This specimen is closely allied in general form to *D. jouberti*. It differs in the possession of a postfrontal which is apparently absent in *D. jouberti* and in the elevated pineal foramen. It is probable, however, that the two species are closely allied.

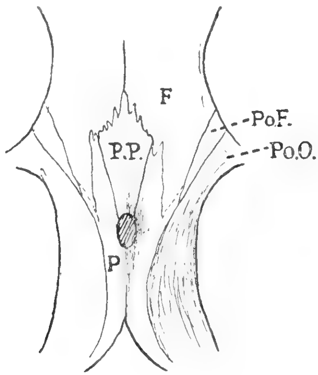

FIG. 31.—*Dicynodon psittacops*, Br. Skull No. 2660. Preparietal region. Natural size.

Another specimen (Cat. No. 3034) from the type locality is about four-fifths the size of the foregoing, and agrees with it in general proportions. The eyes are moderately small and rounded. The preparietal is of slightly different shape, being more regularly oval, although still considerably longer than broad. Its relations with the frontals, the parietals, and the pineal foramen are as in the larger specimen.

Type.—Skull and skeleton in the American Museum.

Locality.—Beaufort West, C.P.

Horizon.—Lower Beaufort Beds. (*Endothiodon* zone.)

DICYNODON RECURVIDENS, Owen.

1876. Owen. Cat. Foss. Rept. S. Afr., p. 46; pl. lxix, figs. 3 and 4.

Founded on a crushed skull and lower jaw. Small. Orbit wholly in anterior half of skull; canine projects below middle of orbit, and is

recurved; parietal bar narrow, postorbitals almost meeting one another.

Type in the British Museum.

Locality.—Fort Beaufort, C.P.

Horizon.—Lower Beaufort Beds. (*Endothiodon* zone (?)).

Dicynodon trigoniceps (Br.).

1901. Broom, *Oudenodon gracilis* (pars). Proc. Zool. Soc., p. 162.

1904. Broom, *Oudenodon trigoniceps.* Rec. Albany Mus., i, p. 73; pl. iv, fig. 2.

Founded on a well-preserved skull. Small. Parietal region as broad as frontal, and comparatively flat. Occiput slopes forward. Orbits look upwards and slightly outwards. Slight supraorbital ridge, and less distinct median ridge between the two frontals. Narrow, fairly long preparietal.

Locality.—Pearston, C.P.

Horizon.—Lower Beaufort Beds. (Probably top of *Endothiodon* zone.)

Dicynodon alticeps, Br. & Htn.

1913. Broom & Haughton. Ann. S.A. Mus., xii, 1, p. 37; pl. vii, figs. 1, 2.

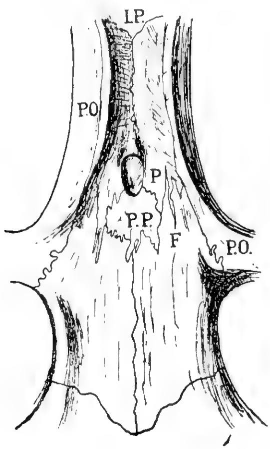

Fig. 32.—*Dicynodon alticeps*, Br. and Htn. Type. No. 2347. Parietal and frontal regions. × ½.

In the original description of this species a mistake was made with regard to the limits of the preparietal bone, which led Dr. Broom to

include the form in his genus *Diictodon*, characterised by the enclosure of the pineal foramen by the preparietal. It is clear, however, that the preparietal forms only a portion of the border of the foramen, the larger part of the opening being enclosed by the parietals, which are fused together in their anterior half.

The figure shows the preparietal to be remarkably short and broad, of irregular shape and with convoluted borders. Moreover, there does not appear to be a distinct postfrontal. A possible frontal-postfrontal suture on the right-hand side of the skull is not paralleled on the other side, and it is thus probably a crack.

The parietal bar has a deep median groove behind the pineal foramen, flanked by the crests formed partly of parietal and partly of postorbital.

Type.—Skull. (S.A. Mus. Cat. No. 2347.)

Locality.—One mile E. of Oudeberg, Graaff Reinet, C.P.

Horizon.—Lower Beaufort Beds. (Bottom of *Cistecephalus* zone.)

Dicynodon bolorhinus (Br.).

1911. Broom, *Oudenodon bolorhinus.* Proc. Zool. Soc., p. 1076; pl. lxiii, fig. 10.

Founded on a somewhat crushed and weathered preorbital portion of a skull. Snout extremely short, bringing the front of the palate almost under the orbit. Nasals thickened to form a rounded boss overhanging the nostril. Orbit large. Frontals short and comparatively narrow.

The form, according to Dr. Broom, is comparable with *D. strigiceps*; but the latter has a much larger nostril and has the caniniform process much farther back.

Type in the American Museum of Natural History.

Locality.—Kuil's Poort, Beaufort West, C.P.

Horizon.—Lower Beaufort Beds. (Top of *Endothiodon* zone or bottom of *Cistecephalus* zone.)

Dicynodon breviceps, Htn.

1915. Haughton. Ann. S.A. Mus., xii, 2, p. 59; pl. xi, fig. 2.

The type and only known specimen is in an incomplete and crushed condition, but its features are sufficiently well displayed to differentiate it from other species. The skull is remarkable in being as broad as it

is long. The parietal bar is short, and the postorbitals almost meet behind the pineal foramen. The postfrontal forms a long part of the orbital border, stretching outwards along the postorbital bar; but it narrows rapidly posteriorly and does not reach the level of the pineal foramen.

The snout is short, and the caniniform process is well forward below the nostril. The nostrils are close together and look forwards and outwards.

Type.—Skull and lower jaw. (S.A. Mus. Cat. No. 2366.)

Locality.—Voetpad, Murraysburg, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

DICYNODON CAVIFRONS, Br. & Htn.

1917. Broom & Haughton. Ann. S.A. Mus., xii, 5, p. 120; fig. 20.

This species has a remarkably short and narrow palate compared with the width between the jugal arches. The tusks pass downwards below the front of the orbit; but seen from in front the edges of the caniniform processes curve inwards, so that the width between the tusks is small.

The occipital condyle is tripartite and short. The foramen jugulare lies at the level of the top of the condyle and looks backwards. The paroccipital process is very stout, especially laterally, and its lower border is strongly concave. The basisphenoidal tubera are not especially prominent, but lie well below the condyle. The quadrates set close together.

Type.—Skull. (S.A. Mus. Cat. No. 747.)

Locality.—Fraserburg, C.P.

Horizon.—Lower Beaufort Beds. (Probably *Cistecephalus* zone.)

DICYNODON GRANDIS, sp. nov.

A complete skull and lower jaw obtained on the farm Dunedin, Beaufort West, C.P. (S.A. Mus. Cat. No. 2679), seems to belong to a new species. It is somewhat crushed laterally, and the sutures do not show very clearly—the specimen being presumably an old individual. The chief measurements are:

Greatest length	553 mm.
Greatest breadth	453 ,,
Interorbital width	123 ,,
Intertemporal width	64 ,,
Basal length	430 ,,
Width between caniniform processes . .	101 ,,

The orbit is wholly in the anterior half of the skull. The nostrils are large; within the nostril can be seen a large septomaxilla which does not appear on the face.

The postorbitals almost meet one another on the parietal bar, forming a marked parietal crest. In front of the crest is a small oval pineal foramen, lying somewhat in a hollow, and not raised on a boss of bone as in *Eocyclops longus.* In front of the pineal foramen, and forming its anterior border, is a small preparietal, lozenge-shaped. The interfrontal suture is seen along a median ridge, which terminates somewhat in front of the pineal foramen. The postfrontal was a narrow, inconspicuous bone lying for a short distance between the postorbitals and the frontals.

The occipital plate is very broad, and the condyle is comparatively small. As far as can be seen, the structure is typically Dicynodont. The foramen magnum is very small compared with the size of the plate.

The palate is long and narrow, the premaxilla furnished with two ridges, separated by a median hollow. The distance between the caniniform processes, which are placed below the front of the orbit, is 101 mm. The pterygoids are strong, the minimum width across them being 48 mm.

The lower jaw is complete, and in good condition. The length from the beak to the back of the articular is 455 mm., while the greatest depth of the dentary is 110 mm. The front of the jaw is narrow, and has an upwardly directed beak which fits into the front of the palate. At a distance of 110 mm. behind the beak the rami begin to separate more rapidly, and the distance between the outer sides of the articulars is 280 mm. The front of the jaw is prow-shaped, inclined at an angle of about 45° to the plane of the upper edges of the dentary.

The dentary is the largest bone and has a deep symphysis. The splenial is large, and forms more than half of the inner side of the front half of the jaw and enters largely into the symphysis. Its upper process lies on the prearticular, while the lower process is wedged between the prearticular and the angular. The angular is not very large. An anterior process passes between the dentary and splenial almost to the symphysis. On the lower border of the jaw the plate-like angular forms an overhanging, projecting flange. The pre-articular, surangular, and articular are typically Anomodont.

Type.—Skull and lower jaw. (S.A. Mus. Cat. No. 2679.)

Locality.—Dunedin, Beaufort West, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Dicynodon halli, Watson.

1914. Watson. Ann. Mag. Nat. Hist., ser. 8, xiv, p. 95; fig. 1.

This species is closely allied to *D. planus*, and, according to Dr. Broom, the two names may be synonymous. It is probable that Watson was mistaken in showing the preparietal as extending along both sides of the pineal foramen. The line shown in his figure I take to be a part of the V-shaped suture between the frontal and the parietal. It would seem better to keep the two species distinct on account of the difference in the ratios between the frontal and intertemporal widths. In *D. planus* the interorbital width is equal to, or slightly greater than, the intertemporal width and the parietal bar is of constant width throughout. In *D. halli* the relative widths are reversed, and the parietal bar gradually broadens posteriorly.

A specimen in the Museum collection agrees closely with the figure given by Watson. It is a slightly distorted skull and lower jaw (S.A. Mus. Cat. No. 3414) collected from the *Cistecephalus* zone at Dunedin, Beaufort West, C.P., by the Rev. J. H. Whaits. It shows the same small face and general proportions as the type, and has apparently the same small occipital condyle without tripartite division. A curious feature is the height of the basicranium above the level of the quadrates, which bones are also close together, lying directly below the post-temporal vacuities. In consequence the stapes must have been steeply inclined and the fenestra ovalis looks almost wholly downwards. The basisphenoid tubera were not very prominent.

The bones of the top of the skull are well seen. The preparietal forms only the anterior border of the pineal foramen and is broadest near the front, being somewhat truncate anteriorly. The other bones are as shown by Watson.

Type.—Skull and skeleton in the British Museum.

Locality.—Kuil's Poort, Beaufort West, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Dicynodon ingens, Br.

1907. Broom. Ann. Natal Govt. Mus., i, p. 168; pl. xxviii, figs. 1–4.

Founded on the well-preserved palatal portion of a skull. Large; palate longer than broad; prominent median ridge on palate; front of snout unusually straight, with low median ridge and slight lateral one. Nostril large.

Type in the Natal Museum, Pietermaritzburg.

Locality.—Ennersdale, Natal.

Horizon.—Lower Beaufort Beds. (Probably top of *Cistecephalus* zone.)

Dicynodon kolbei (Broom).

1911. Jaekel, *Udenodon sp.* Die Wirbeltiere, p. 192; figs. 210–212.

1912. Broom, *Oudenodon kolbei.* Ann. S.A. Mus., vii, 5, p. 337; figs. 1–5.

1913. Broom, *Diictodon kolbei.* Bull. Amer. Mus. Nat. Hist., xxxii, p. 454.

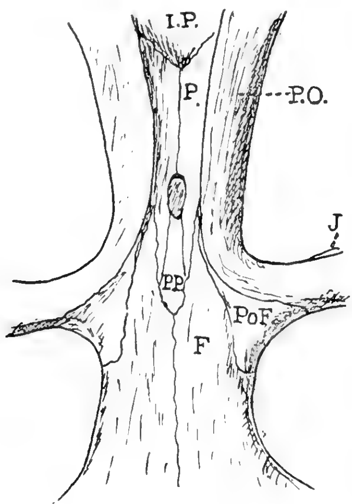

Fig. 33.—*Dicynodon kolbei* (Broom). Type. No. 1886. Parietal and frontal regions. × ½.

Re-examination of the type of this form shows that the structure of the preparietal region has hitherto been misinterpreted. A figure is here given of this region. It will be seen that, instead of being a long bone entirely enclosing the pineal foramen, the preparietal is comparatively small and forms the anterior border only of the foramen.

In other points there seems nothing to add to the description given by Dr. Broom.

Type.—Skull. (S.A. Mus. Cat. No. 1886.)

Locality.—Rhenosterfontein, Beaufort West, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Dicynodon lacerticeps, Owen.

1876. Owen. Cat. Foss. Rept. S. Afr., p. 30; pl. xxii.
1890. Lydekker. Cat. Foss. Rept. & Amphib., iv, p. 18.

Founded on a skull with lower jaw. Comparatively small. Greatest length of type skull about 158 mm. Orbits directed forwards and laterally, sub-circular, almost as large as the temporal openings. Inter-orbital width 25 mm. Temporal fossae directed upwards. Post-orbitals almost meet on the parietal bar; parietals narrow. Root of tusk inclined forwards and downwards. Parietal foramen probably on a level with the front of the temporal fossae.

Type in the British Museum.

Locality.—"Tarka prolongation of the Winterberg," C.P.

Horizon.—Lower Beaufort Beds. (Probably *Cistecephalus* zone.)

Dicynodon laticeps, Broom.

1912. Broom. Proc. Zool. Soc., p. 868; pl. xcii, figs. 12, 13.
1915. Broom. Bull. Amer. Mus. Nat. Hist., xxv, 2, p. 131; fig. 17.

Two skulls collected by the Rev. J. H. Whaits from the Graaff Reinet District are interesting as showing the changes which apparently take place with the advance from youth to maturity. One skull (S.A. Mus. Cat. No. 3423) is a fully grown male agreeing closely with the type. The other (S.A. Mus. Cat. No. 3328) is a young male, and, although it displays main features in common with the other, shows some points of difference in detail. The latter skull is incomplete, but the sutures of the top of the skull are beautifully displayed.

The two skulls are of the broad-headed variety, with a broad frontal region and a broad parietal region—narrowest in front. The orbits are large and triangular and the snout short. The nostril is fairly large. In the old skull the nostril is overhung by a large projecting nasal boss; but in the smaller skull this boss is very rudimentary. The internasal width is large.

The postorbitals are long and slender, and, although they form the upper borders of the temporal fossae, in neither skull do they appear on the top of the parietal bar behind the pineal foramen. The whole of the broad expanse of the posterior part of the bar is formed of the parietals, the postorbitals facing entirely outwards. The preparietal is large; but, while in the younger skull it is raised on a bony eminence above the level of the top of the skull, in the older specimen

the foramen is sunken but is surrounded by a slightly raised rim of bone.

In each skull the preparietal stands well above the level of the frontals on either side of it. The smaller skull has a very large, lozenge-shaped preparietal whose anterior end is considerably in advance of the postorbital bar. The preparietal of the other is shorter. The bone almost completely surrounds the pineal foramen.

The frontals meet the nasals in a straight suture at the level of the front of the orbit. Posteriorly they flank the preparietal for a long distance, and each is hollowed out at the side of that bone. The post-

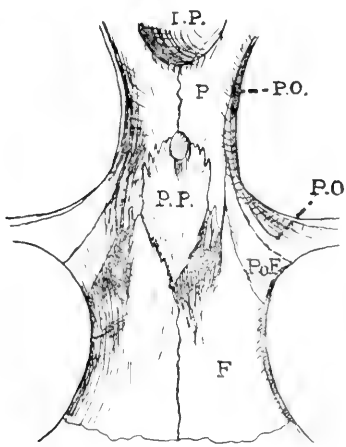

FIG. 34.—*Dicynodon laticeps*, Br. Skull, No. 3328 (Young). Preparietal region. × ½.

frontal is a long, narrow bone, which in each specimen occupies a somewhat sunken area between the frontal and postorbital.

The chief changes which seem to take place with increasing age, therefore, are the development of the nasal and prefrontal bosses, the sinking-in of the pineal foramen, and the decrease in size of the preparietal bone. Since the size and shape of this bone in the larger skull seems to agree exactly with that in the type specimen we can scarcely look upon the difference in size as an individual feature, but must reckon it as the result of a change due to age.

Other interesting features of the larger (and more complete) skull are the short, broad palate, the large tusks, the very strong keel formed by the pterygoids behind the posterior narial fossa, the narrowness between the quadrates, the large tabulare seen on the back of the

skull, and the long upward extension of the jugal behind the postorbital.

Type in American Museum of Natural History.

Locality.—Grootvlei (part of Paardekraal), Beaufort West, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Dicynodon leoniceps, Owen.

1876. Owen. Cat. Foss. Rept. S. Afr., p. 32; pls. xxiv–xxvi.
1890. Lydekker. Cat. Foss. Rept. & Amphib., iv, p. 19.

Founded on an imperfect skull; large, long, and narrow. Orbits directed mainly laterally; interorbital bar very wide, parietal bar long and narrow, postorbitals almost above parietals; temporal fossa long and comparatively narrow; skull high.

A skull which I was permitted to examine through the kindness of the Director of the Port Elizabeth Museum (No. 68, P.E. Mus.) seems to be referable to this species. It has the following approximate measurements:

Greatest length	300	mm.
Length from snout to front of orbit	60	,,
Interorbital width	65	,,
Intertemporal width	33	,,
Width across nasal overhang	63	,,
Orbital diameter	60	,,
Basal length	250	,,
Width between base of tusks	32	,,

The condition of the skull is such that sutures are difficult to determine. The bone is soft and is caked with a hard, crystalline matrix. There appears to have been a large postfrontal; but the preparietal, if present, could have been but small. The pineal foramen is almost covered by the postorbitals. The chief feature of the skull is its great height, *i. e.* the length of the downward portion of the squamosal.

Type in the British Museum.

Locality.—"Gats River, Sneeuwberg, Graaff Reinet," C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone (?).)

Dicynodon leontops, Br.

1913. Broom. Bull. Amer. Mus. Nat. Hist., xxxii, p. 451; fig. 12.
1915. Broom. Bull. Amer. Mus. Nat. Hist., xxv, 2, p. 132; fig. 19.

Large. Comparable with *D. leoniceps* and *D. pardiceps;* frontals relatively narrower than in these types, passing back in almost parallel

processes to plane of back of pineal foramen; preparietal small and narrow. Interorbital width three times the intertemporal width.

Type in the American Museum of Natural History.

Locality.—Bethulie, O.F.S.

Horizon.—Lower Beaufort Beds. (Top of *Cistecephalus* zone.)

Dicynodon lissops, Br.

1913. Broom. Bull. Amer. Mus. Nat. Hist., xxxiii, p. 450; fig. 11.

Skull of medium size. Comparable with *D. lacerticeps*. Eye wholly in anterior half of skull. Nostril fairly large, well forward. Large septomaxillary which just appears on face. Snout rounded and smooth. Frontals pass well forward. Interorbital width : intertemporal width : : 5 : 3. Prefrontal large. Preparietal large. Postorbitals nearly meet on parietal bar. Postfrontal very narrow.

Type in the American Museum of Natural History.

Locality.—Wilgebosch, New Bethesda, Graaff Reinet, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Dicynodon moschops, Br.

1913. Broom. Bull. Amer. Mus. Nat. Hist., xxxii, p. 447; figs. 7–8.
1915. Broom. Bull. Amer. Mus. Nat. Hist., xxv, 2; fig. 23.

Skull of medium size, almost as wide as long. Snout broad, markedly bent near front of frontal. Nostrils small, roofed by marked projection of nasal. Septomaxilla appears on face, joining with lachrymal and separating nasal from maxilla. Frontals broad. Postfrontals almost entirely hidden. Preparietal small. Pineal foramen large, broader than long. Interparietal large, forming considerable part of upper surface of skull.

Type in American Museum of Natural History.

Locality.—Oudeberg, Graaff Reinet, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Dicynodon mustoi, Htn.

1915. Haughton. Ann. S.A. Mus., xii, 2, p. 58; pl. xi, fig. 1.

This form, although at first sight somewhat similar to *D. kolbei*, differs sufficiently to retain separate specific rank. In the original description given, it was considered that the preparietals of the two forms were very distinct; but although the revelation of the true structure of the extent of the bone in *D. kolbei* removes this point of

difference, the two species can still be separated by the difference in shape of the anterior part of the postfrontal, the greater relative width between the postorbitals in *D. mustoi*, and the fact that in *D. mustoi* the interorbital width is less than the intertemporal, whereas in *D. kolbei* the reverse is the case.

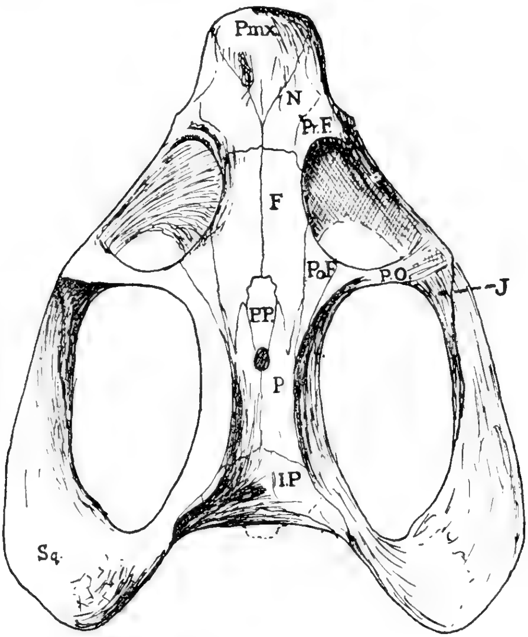

Fig. 35.—*Dicynodon mustoi*, Htn. Type. No. 2674. × ½.

Type.—Skull. (S.A. Mus. Cat. No. 2674.)
Locality.—Dunedin, Beaufort West, C.P.
Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Dicynodon planus, Broom.

1913. Broom. Bull. Amer. Mus. Nat. Hist., xxxii. p. 452; figs. 13, 14.

A medium-sized Dicynodon with comparatively short face, and breadth about five-sixths of the length. The interorbital width equal to, or slightly greater than, intertemporal width. Orbits wholly in the anterior half of the skull, looking mainly upwards. Postfrontal large, postorbitals each forming one-third of the parietal bar.

A skull (S.A. Mus. Cat. No. 2364) from Dunedin, Beaufort West (*Cistecephalus* zone) agrees with the type except in being somewhat smaller. The bones of the top of the skull are beautifully displayed. Here, as in *D. halli*, the quadrates are near together. The occipital condyle is small, but is feebly tripartite in character. The occipital plate is vertical. The right stapes is showing, resting medially in the foramen ovalis, which looks outwards and downwards.

Type.—Skull in the American Museum of Natural History.

Locality.—Kuil's Poort, Beaufort West, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Dicynodon platyceps, Br.

1913. Broom. Bull. Amer. Mus. Nat. Hist., xxxii, p. 444; fig. 4.
1914. Broom. Phil. Trans. B 206, p. 44; pl. v, figs. 46, 47, 48.
1915. Broom. Bull. Amer. Mus. Nat. Hist., xxv, 2, p. 138; fig. 27.

Skull and skeleton of medium size. Skull flattened, considerably longer than broad. Orbits look upwards and outwards. Tusks feeble. Frontal region hollowed, supraorbital margins elevated. Large preparietal forms anterior border of large pineal foramen. Postfrontal long and narrow.

Type in American Museum of Natural History.

Locality.—New Bethesda, Graaff Reinet, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Dicynodon pygmaeus, Br. & Htn.

1917. Broom & Haughton. Ann. S.A. Mus., xii, 5, p. 123; fig. 23.

Three skulls in the South African Museum collection can be definitely assigned to this species. They are:

Cat. No. 2664. Type from Dunedin, Beaufort West, C.P.;

Cat. No. 2668 from the same locality; and

Cat. No. 3352 from Highlands, top of Nieuweveld, Beaufort West, C.P.

All are from the *Cistecephalus* zone.

The three skulls are almost of the same size; but it is probable that the type has been flattened by vertical crushing, so that the width given in the original description is greater than the skull actually had in life. The maximum width was probably between 40 and 45 mm., and the orbit looked at least as much laterally as upwards. The orbit is round, and the postorbital arch rather weak.

The skull from Highlands is tusked; the others are females. The

tusk passes mainly downwards and its base lies just in front of the orbit.

In the male skull the pineal foramen is slightly farther back along the parietal bar than in the type ; but the relative shapes and sizes of the bones around the foramen remain the same.

The foramen magnum is large and the post-temporal fossa is seen to be well up on the occipital plate (No. 3352), so that the paroccipital processes are deep and fairly short.

The only other small species known from the *Cistecephalus* zone is *D. testudirostris.* The two species are readily distinguishable at a glance by the nature of the beak. *D. testudirostris* is especially characterised by the strength of the beak and the vertical inclination of the front of the snout. The suborbital bar has its lower border turned abruptly downwards at the level of the middle of the orbit, so that there is a deep portion of the maxilla underlying the front half of the eye. The two species agree in the narrowness of the frontal region compared with the breadth of the parietal bar, in the narrowing of the parietal bar posteriorly and in the possession of an insignificant postfrontal. In *D. testudirostris,* however, the postorbitals meet above the parietals at the back of the parietal bar, while in *D. pygmaeus* they don ot.

D. pygmaeus has a fairly close ally apparently in *D. ictidops* from the zone below, from which form it might possibly have been derived by the reduction of the postfrontal and slight broadening of the parietal crest.

Type.—Skull. (S.A. Mus. Cat. No. 2664.)

Locality.—Dunedin, Beaufort West, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Dicynodon rogersi, Br. & Htn.

1917. Broom & Haughton. Ann. S.A. Mus., xii, 5, p. 121; figs. 21, 22.

This form is closely allied to *D. kolbei,* and for some years the type specimen was considered to be an example of that species. The differences between the two forms are, however, worthy of recognition, and have been given in the paper cited above.

One half only of the occipital plate is preserved, and the condyle is lacking. The lateral vacuity is at the level of the middle of the rather small foramen magnum. The tabulare is not large. The stapes is short and its outer end is considerably lower than its inner end.

The lower jaw is very long and comparatively shallow;

Type.—Skull and lower jaw. (S.A. Mus. Cat. No. 2356.)

Locality.—Thee Kloof, Fraserburg, C.P.

Horizon.—Lower Beaufort Beds. (Probably bottom of *Cistecephalus* zone.)

Dicynodon strigiceps, Owen.

1855. Owen. Trans. Geol. Soc., 2nd ser., vol. vii; pl. vi, figs. 2, 3.
1876. Owen, *Oudenodon (?) strigiceps.* Cat. Foss. Rept. S.A., p. 61; pl. xliv, fig. 4.
1890. Lydekker, *Udenodon strigiceps.* Cat. Foss. Rept. and Amphib., iv, p. 30.

Founded on the anterior part of a skull. Frontal region broad; caniniform process descends vertically below orbit; rostral region descends in convex semicircular contour to beak; orbits in fore part of head, directly above the nares.

Type in the British Museum.

Locality.—"Tarka prolongation of the Winterberg," C.P.

Horizon.—Lower Beaufort Beds. (Probably top of *Cistecephalus* zone.)

Dicynodon testudiceps, Owen.

1855. Owen. Trans. Geol. Soc., 2nd ser., vol. vii, p. 71.
1876. Owen. Cat. Foss. Rept. S.A., p. 45; pl. xliv, figs. 1–3.
1890. Lydekker. Cat. Foss. Rept. and Amphib., iv, p. 24.

Founded on the anterior two-thirds of a skull. Front of skull short and broad; muzzle deflected abruptly downwards. Interorbital width 35 mm.

Type in the British Museum.

Locality.—"Tarka prolongation of the Winterberg," C.P.

Horizon.—Lower Beaufort Beds. (Probably *Cistecephalus* zone.)

Lydekker gives the locality as "from the Stormberg Beds of the Karroo system on the Modder tributary of the Orange River."

Dicynodon testudirostris, Br. & Htn.

1913. Broom & Haughton. Ann. S.A. Mus., xii, 1, p. 36; pl. vii, figs. 3, 4.

In the photographs given with the original description of this type the sutures were not adequately displayed, and a drawing is therefore given of the arrangement of the bones in the preparietal region. The

preparietal is seen to be a fairly large bone which touches only a minute fraction of the pineal foramen. The postfrontal is long and narrow, and the parietal has but one anterior process passing between the frontal and preparietal.

Since the original paper the occiput and basicranium of the type skull have been cleared of matrix. The occipital plate is nearly vertical. The foramen magnum is large, its upper margin being more than halfway up the skull. Consequently both the interparietal and supraoccipital are somewhat shallow bones. Sutures are not well shown on the plate, so that the exact limits of each bone cannot be determined. The lateral vacuity lies at the level of the middle of the

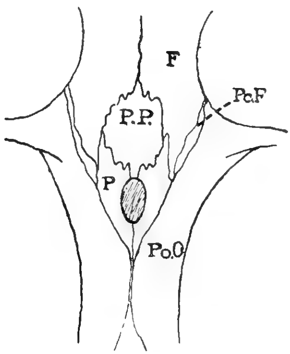

Fig. 36.—*Dicynodon testudirostris*, Br. & Htn. Type. No. 2354. Preparietal region. Natural size.

foramen magnum. The occipital condyle is tripartite with a large central pit. The foramen for the 9th–12th nerves looks almost entirely backwards and outwards; it is large, and most of its border is formed by the paroccipital.

The basioccipital tubera are prominent, and wholly below the level of the condyle. The fenestra ovalis is almost as low as the quadrate. Between the tubera the basioccipital is deeply grooved. The basisphenoid is short. Anterior to it the pterygoids form a broad, short plate 11 mm. wide. Just behind the interpterygoid vacuity is a median knob.

The quadrato-jugal is peculiar in that it is apparently not anchylosed to the quadrate. On the left side it is seen in position, lying on the downward process of the squamosal and widely separated at the articular end from the quadrate. On the other side it is detached from the skull.

The chief measurements of the type are:

Greatest length	ab. 86 mm.
Greatest width	56 ,,
Snout to front of orbit	18 ,,
Length of orbit	20 ,,
Interorbital width	16 ,,
Intertemporal width (min.)	12 ,,
Basal length	72 ,,
Width between caniniform processes	26 ,,

Type.—Skull. (S.A. Mus. Cat. No. 2354.)

Locality.—Dunedin, Beaufort West, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Dicynodon tigriceps, Owen.

1855. Owen. Trans. Geol. Soc., vii, 2nd ser., p. 233.
1876. Owen. Cat. Foss. Rept. S.A., p. 38.
1876. Owen, *Dicynodon baini.* Cat. Foss. Rept. S.A., p. 36; pls. xxx–xxxv (*non* xxxvi, xxxvii).
1889. Seeley. Phil. Trans., 1889 B, p. 236, pl. xiii.
1890. Lydekker. Cat. Foss. Rept. and Amphib., iv, p. 24.

This species is doubtfully represented in the South African Museum collection by an incomplete skull (No. 749) from Pearston, C.P. The front of the skull is very weathered and somewhat distorted, but the occipital plate is in a good state of preservation. The basisphenoid tubera are seen to project very considerably below the level of the condyle, and between them the basioccipital is deeply hollowed out. The paroccipital process is very massive and its lower border strongly concave. The foramen jugulare looks entirely backwards, and the post-temporal vacuity lies at the level of the middle of the foramen magnum.

Type.—Skull in the British Museum.

Locality.—Gonzia River, Kaffraria. ("*D. baini*" is from Fort Beaufort, C.P.)

Horizon.—Lower Beaufort Beds.

Dicynodon truncatus (Br.).

1899. Broom, *Oudenodon truncatus.* Ann. S.A. Mus., i, p. 455; pl. x, fig. 4.

Founded on the crushed and weathered anterior portion of a skull. Beak almost square, with median and two lateral ridges. Premaxilla

forms nearly the whole of the front of the roof of the mouth. No septomaxilla showing on face. Nostrils well advanced, large. Caniniform process just behind plane of back of nostril.

Through the courtesy of the Director of the Port Elizabeth Museum I have been enabled to see the type. It is an unsatisfactory specimen, and its chief interest lies in the fact that it was probably obtained from a locality from which very few Dicynodont or other reptilian remains are known.

Type in the Port Elizabeth Museum.

Locality.—Probably Hanover, C.P.

Horizon.—Lower Beaufort Beds. (Zone of *Endothiodon* or of *Cistecephalus.*)

Dicynodon tylorhinus, Br.

1913. Broom. Bull. Amer. Mus. Nat. Hist., xxxii, p. 448; figs. 9, 10.

Skull of medium size, as broad as long. Snout very broad, preorbital region very short. Beak short, nostrils small. Above nostrils, nasals form two prominent knobs which pass forward well in front of premaxilla. Frontal region flat and broad. Interorbital width : intertemporal width : : 9 : 4. Preparietal large, postfrontals entirely hidden. Postorbitals meet behind the pineal foramen.

Type in American Museum of Natural History.

Locality.—Wilgebosch, New Bethesda, Graaff Reinet, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Dicynodon whaitsi, Br.

1913. Broom. Bull. Amer. Mus. Nat. Hist., xxxii, p. 443; fig. 3.
1915. Broom. Bull. Amer. Mus. Nat. Hist., xxv, 2, p. 142; fig. 33.

This species is one of the largest of the Dicynodons. The original description is as follows: "The snout is narrow and deep and the nostrils large. The orbits are placed near the middle of the head. The postorbital arch is powerful. The parietal region is broad, and the posterior ramus of the postorbitals unusually well developed. The pineal foramen is situated well behind the postorbital arch. Behind and on about two-fifths of each side it is bordered by the parietals. The rest of the foramen is bordered by the large preparietal. The frontals extend back on each side of the preparietal to nearly the plane of the back of the foramen. The postfrontals are moderately large."

The Rev. J. H. Whaits has recently collected for the South African

Museum from Adendorp Commonage, Graaff Reinet, C.P., a skull, lower jaw and partial skeleton of an example of this species. The skull is somewhat larger than the type. It is flattened laterally, and the relation of the bones of the top of the skull cannot be accurately determined. But there can be no doubt as to the specific identity of the skull with the type figured by Broom. The species is a readily identifiable one in general appearance. In addition to this specimen we have another skull from Dunedin, Beaufort West—even larger than the other and similarly flattened—which shows exactly the same features. The orbit is circular, looking almost entirely outwards, and is in the front half of the skull. In the Adendorp specimen (S.A. Mus. Cat. No. 3714), however, the pineal foramen seems to be nearer the postorbital arch than in the type. Otherwise the general proportions of the top of the skulls are the same. The postorbital arch is exactly midway along the skull in this specimen, and slightly in advance of the middle line in the Dunedin skull (S.A. Mus. Cat. No. 2681).

The importance of the Adendorp specimen lies in the fact that with the skull and lower jaw are a number of associated limb-bones, vertebrae, and portions of the girdles. The postcranial skeleton of the Anomodonts is well known in its general features; but hitherto there has been wanting detailed knowledge concerning the features of the various species, so that it is impossible almost to correlate the many skeletal portions of Dicynodonts found with the known skull types. For example, the bones named by Owen as *Platypodosaurus robustus* have been variously conjectured to be bones of *Eocyclops magnus*, *E. longus*, and *Dicynodon grandis*, but not one of the three types is known from more than the skull, so that the point at issue cannot yet be settled. Hence any light shed upon the subject by the discovery of skeletal remains in connection with skulls is welcome.

In this specimen the bones are preserved in too hard a matrix to permit of their being very satisfactorily cleaned, and many of them are incomplete, having apparently suffered a certain amount of fracture and rubbing before their final entombment. They agree with the normal type of Dicynodont limbs, and thus their measurements alone are given.

Scapula.—The upper border of the left scapula is missing. The bone as preserved has a length of 325 mm. The basal breadth is 125 mm. and the minimum breadth of the bone is 80 mm. Superiorly the blade widens. The anterior point of the acromion process is 100 mm. above the base of the bone. At the glenoid cavity the bone is strongly thickened to a thickness of 80 mm.

Humerus.—The right humerus is nearly complete, lacking the proximal end, which is present in a more fragmentary left humerus. The bone is larger than that of *Platypodosaurus*, but has the same characters except that it does not seem to have the "hook" at the distal end of the deltoid crest. The length of the bone is 295 mm.; the breadth of the proximal end is 190 mm., and of the distal end 175 mm. The minimum breadth across the shaft is 75 mm., and the distance of the top of the epicondylar foramen from the distal border of the bone is 95 mm.

Radius.—The greatest length of the radius is 215 mm., the breadth of the proximal surface 90 mm., and of the distal 83 mm. The proximal articular surface is an elongate oval, its inner half concave. The distal end of the bone is relatively much stouter than in *D. trigoniceps*, the articular surface having a thickness of 62 mm. The middle of the shaft is thin.

Ulna.—The ulna is longer than the radius, having a total length of 237 mm. The olecranon process is not at all strongly developed, therein showing a difference from that of *D. trigoniceps.* The greatest breadth proximally is 112 mm. At its narrowest the shaft is 43 mm. broad, and distally the bone is slightly expanded to a breadth of 67 mm. The distal articular surface is about 35 mm. thick. The whole bone is somewhat thinned by flattening.

Type.—Larger part of skull in the American Museum of Natural History.

Locality.—Uitspanfontein, Beaufort West, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Genus CHELYRHYNCHUS, gen. nov.

Chelyrhynchus lachrymalis, gen. et sp. nov.

The specimen under consideration consists of an almost perfect uncrushed skull collected by the Rev. J. H. Whaits on the Graaff Reinet Commonage (S.A. Mus. Coll. 3334).

It is a medium-sized skull having a maximum length of 200 mm., and a greatest breadth across the squamosals of 180 mm. The other chief measurements are:

Interorbital width	30 mm.
Intertemporal width	37 ,,
Basal length	179 ,,
Distance from snout to front of orbit . .	50 ,,
Distance between nares and orbit	17 ,,
Width between caniniform processes . .	60 ,,

The snout is narrow and the face short.

The maxilla passes back to below the middle of the orbit and forms most of the cheek. It has a small palatal portion upon which there is no trace of any molar teeth.

The septomaxilla lies wholly within the nostril, forming the posterior lower border, and articulates with the nasal, lachrymal, and maxilla.

The lachrymal extends from the orbit to the nostril as in *Tropidostoma*. It forms a large portion of the anterior border of the orbit, but is much shallower on the cheek. At the nostril it abruptly narrows, and it has a short articulation with the septomaxilla.

The nostril is overhung by a small nasal boss.

The frontal reaches forward to the plane of the back of the nostril, separating the nasals from each other posteriorly.

The chief features of the skull-top are the slightly thickened supra-orbital border, the width of the intertemporal region, the absence of a preparietal, and the appearance of the interparietal on the top of the skull.

The postorbital bar is long, but comparatively slender.

The occipital plate is broad, flat, and vertical. The occipital condyle is small and not tripartite, similar to that of *Tropidostoma.*

The foramen jugulare lies on the back of the skull and looks wholly backwards. The paroccipital process is very massive in its outer portion and its outer border inclines strongly medially below. The basisphenoid forms nearly half of the tubera on the inner surface; but it takes no part in the border of the fenestra ovalis, which is bounded posteriorly, medially, and anteriorly by the basioccipital. The fenestra ovalis looks downwards and outwards. The palatal portion of the basisphenoid is short.

In size and shape the skull agrees most closely with *Dicynodon planus, Tropidostoma microtrema,* and the form described by Owen as "*Oudenodon bainii.*" From each it is distinguished by one or more characters.

From *Tropidostoma microtrema,* with which this form agrees in the primitive state of the lachrymal, the skull differs in the absence of molar teeth, in the fact that the postorbitals and parietals are not developed into lateral crests with a groove between them, and in the absence of a preparietal.

The skull has many affinities with the type of *D. planus,* but there is no preparietal. One of the most striking features of the skull is the extension of the lachrymal to the narial border, a feature displayed by *Pareiasaurus* and other skulls of a primitive type. This condition is

closely paralleled in a skull in the S.A. Mus. collection (No. 2364), which has hitherto been considered as a specimen of *Dicynodon planus*, somewhat smaller than the type. In this skull (2364) the lachrymal has a wide orbital end, and narrows rapidly anteriorly, passing forward just to touch the posterior border of the nares, and articulating with a

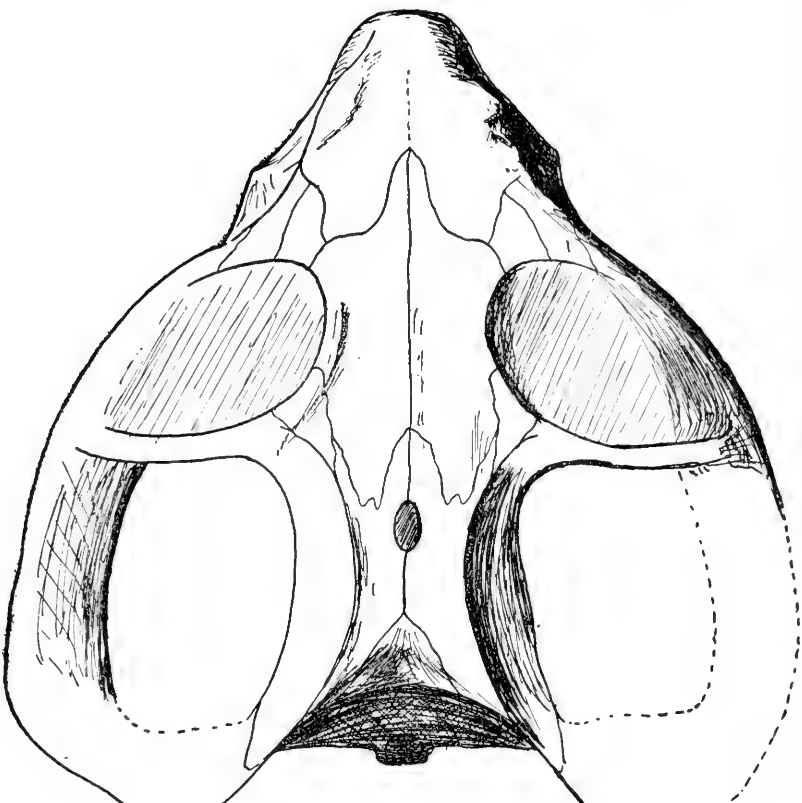

FIG. 37.—*Chelyrhynchus lachrymalis*, Htn. Type. No. 3334. × ·8.

bone within the nostril, presumably the septomaxilla. Certainly the nasal is separated completely from the maxilla. Moreover, skull 2364 agrees fairly closely in shape with that under discussion (3334); the palate is rather longer and narrower, and the occipital condyle shows somewhat, but very little, more of the tripartite division. But, on the other hand, it has a preparietal closely comparable with that of the type of *D. planus* and the whole features of the top of the skull

are those of *D. planus*. (Unfortunately, I am not aware of the exact relations of the lachrymal and the state of the occipital condyle in the type of *D. planus*.)

The question then arises—Can the relations of the bones in the preparieta region be taken as factors of generic, or even of specific, importance among the many forms of *Dicynodon* and its allies? There can be little doubt that the skull (S.A. Mus. 2364) referred to *D. planus* and that under discussion closely resemble one another in all points save in these relations. Nevertheless, following Dr. Broom's classification, they would be placed in different genera according to

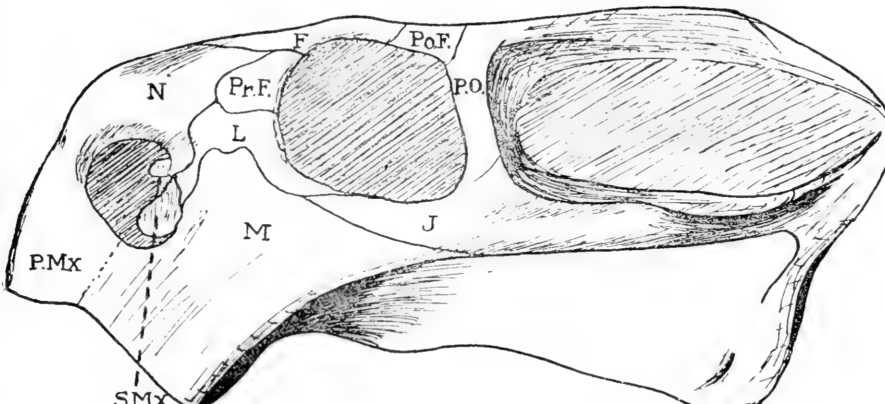

Fig. 38.—*Chelyrhynchus lachrymalis*, Htn. Type. No. 3334. Side view of skull. × ·8.

the presence or absence of the preparietal bone. To settle this question, it is necessary to show that the preparietal is constant in any one species, *i. e.* that forms which agree in all other characters agree also in the possession, shape, and position of the preparietal.

In describing the following Anomodont species, *Dicynodon platyceps*, *Dicynodon ictidops*, *Emydops longiceps*, and *Emydorhynchus palustris*, Dr. Broom was able to base his descriptions upon a number of skulls in each case, and in each instance he remarks upon the close agreement of the individuals within any one species. Moreover, a long series of skulls in the S.A. Mus. collection referred to *Dicynodon jouberti* have the preparietal very constant. On the other hand, the two closely-allied skulls 2364 and 3334 differ in that the former has a long narrow preparietal while the latter is without.

This skull can be taken as the type of a new genus and may be

called *Chelyrhynchus lachrymalis*, gen. et sp. nov., characterised by the following main features:

Skull almost as broad as long. Snout rather short. Orbits large. Intertemporal width greater than interorbital width.

No preparietal, lachrymal extending from orbit to nares, completely separating nasal from maxilla. Septomaxilla within nostril, articulating with lachrymal. Condyle small, and not tripartite. Palate short and broad.

Type.—Skull. (S.A. Mus. Cat. No. 3334.)

Locality.—Commonage, Graaff Reinet, C.P.

Horizon.—Lower Beaufort Beds. (*Endothiodon* zone.)

Genus DIICTODON, Br.

1913. Broom. Bull. Amer. Mus. Nat. Hist., xxxii, p. 453.

Differs from *Dicynodon* in that the pineal foramen is entirely surrounded by the large preparietal.

Diictodon galeops, Br.

1913. Broom. *Loc. cit.*; fig. 15.
1915. Broom. Bull. Amer. Mus. Nat. Hist., xxv, 2, p. 145; fig. 33.

Founded on a small skull. Orbits large, beak and nostril like those of *Dicynodon ictidops*. No septomaxilla on face. Tusk very slender, directed mainly downwards. Prefrontal small. Preparietal large, with broad anterior third and narrower posterior two-thirds. Pineal foramen small. Postfrontal absent.

Type in American Museum of Natural History.

Locality.—Slachter's Nek, C.P.

Horizon.—Lower Beaufort Beds. (Probably top of *Endothiodon* zone.)

Genus EOCYCLOPS, Broom.

Eocyclops longus, Broom.

1913. Broom. Bull. Amer. Mus. Nat. Hist., xxxii, p. 441; figs. 1, 2.

Broom described in 1913 a skull from the Nieuweveld which he called *Eocyclops longus*, and which he said was closely allied with the type of Owen's form *Oudenodon magnus*. Both agree in the structure

of the top of the skull, possessing no preparietal and having the pineal foramen surrounded by the parietals.

Recently the Museum became possessed of a beautiful skull collected at Graaff Reinet by the Rev. J. H. Whaits, which agrees fairly

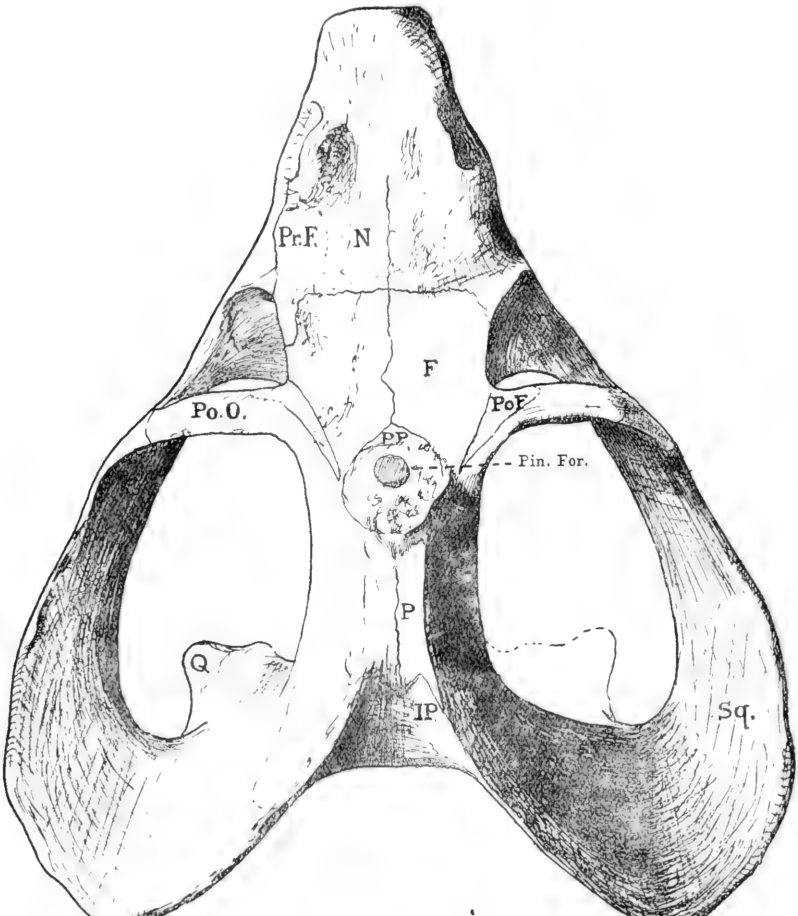

FIG. 39.—*Eocyclops longus*, Br. Skull No. 3425. × ¼ nearly.

closely with *Eocyclops*, but which has a distinct preparietal forming most, if not all, of the boss around the pineal foramen. Of this fact I think there can be no doubt. The sutures between the bones are plainly shown. The interfrontal suture is seen plainly on top of the skull; at its posterior end it divides with two widely diverging arms,

which surround a single bone undivided by any median suture. Sutures are not traceable in the parietal boss; but a short distance behind it a median suture between the two parietals is visible. The evidence thus points strongly to the conclusion that there is a single median bone between the frontals and the parietals, forming at least part of the boss around the pineal foramen. In the type of *Eocyclops longus* there is no doubt that a median suture occurs just in front of the pineal foramen; and the question again arises therefore—How much stress can be laid upon the presence or absence of the preparietal? It is just possible, of course, that in the South African Museum specimen the suture in front of the foramen between two

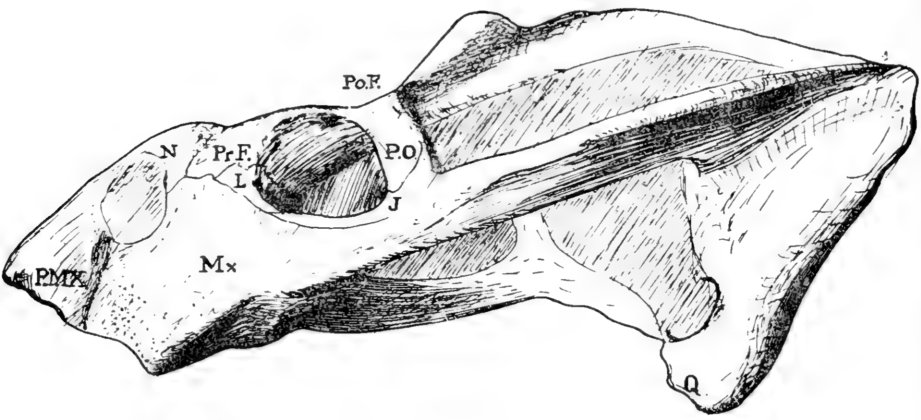

FIG. 40.—*Eocyclops longus*, Br. Skull. No. 3425. × ¼ nearly.

parietals may have been obliterated; but the other sutures on the skull stand out so clearly, and that between the parietals in their posterior part is so obvious, that this does not seem a feasible solution of the matter. It would seem much better to suppose that, although in the smaller Dicynodonts the preparietal is a constant within any one species and is constantly present or absent in the genus, in the case of these very large—and presumably somewhat aberrant—forms the bone is inconstant in character and is not of importance systematically. Certainly the three skulls—S.A. Mus. 3425, type of "*Oudenodon magnus*" and type of *Eocyclops longus*—agree so closely in other regards, as far as can be seen from the somewhat incomplete descriptions, that this one difference can scarcely be held to be sufficient to separate them generically.

The skull from Graaff Reinet is in very fine condition and is worthy

of description. In general outline it resembles closely *Eocyclops longus* and *Eocyclops magnus*, as also in the very large size of the temporal openings. From the former it differs in having a broader intertemporal region, due to the fact that the postorbitals are not so close together, a large portion of the parietals showing between them. From the latter form it differs in having a relatively shorter antorbital portion, and in the fact that the parietal bar is much wider and is not provided with a crest.

The chief measurements are as follows:

Greatest length	502 mm.
Greatest breadth	406 ,,
Interorbital width	105 ,,
Intertemporal width	69 ,,
Snout to front of orbit	150 ,,
Basal length	406 ,,

The nostril is very large, the internasal width rather small. The snout is fairly long and narrow, and is abruptly truncated anteriorly. Above the nostril is a small nasal boss.

There is no septomaxilla seen on the surface. As usual the maxilla forms most of the cheek, and, as in *E. longus*, passes back to below the back of the orbit, being separated for some distance from the jugal by an anterior prolongation of the squamosal.

The lachrymal is fairly small. The lachrymal foramen is well seen within the orbit.

The prefrontal is large, almost reaching the back of the nostril and passing well on to the top of the skull. It is strongly thickened in the supraorbital region.

The nasals are not separated by the frontals, the anterior boundary of the latter running straight across the skull at the plane of the front of the orbit. The frontal forms the whole of the upper border of the orbit and has a backwardly directed process by the side of the pineal boss. In front of that boss each frontal is somewhat excavated. The whole interorbital region is slightly concave.

The orbits are large and distinctly triangular, looking mainly forwards and outwards.

The postfrontal is not well defined, but it was doubtless as in *E. longus*. The postorbital is large, forming the whole of the postorbital bar, articulating at its outer end wholly with the jugal.

The relations of the preparietal and parietals have already been discussed. Behind the parietals is the interparietal, whose anterior end is split up by an intrusion of the parietals. The bone appears partly on top of the skull and partly on the occipital plate, the

transition from one to the other taking place gradually by a regular bending and not abruptly. There is no transverse ridge separating the occiput from the parietal bar.

The occiput is not well displayed and the sutures between the bones are difficult of determination. There is, however, a large tabulare lying outside the interparietal and articulating with the squamosal and the supraoccipital. The occipital condyle is large and of the tripartite type.

The articular surface for the lower jaw is not very much in advance of the occipital condyle. It is very large, and although no suture can be seen running across there is certainly a large quadrato-jugal present. Between it and the quadrate on the anterior face of the descending plate is a large oval foramen.

The palate is long and comparatively narrow. There is no trans-palatine. The jugal passes back within the maxilla to meet the palatine, which articulates anteriorly with the maxilla.

Type in American Museum of Natural History.

Locality.—Grootvlei (part of Paardekraal), Beaufort West, C.P.

Horizon.—Lower Beaufort Beds. (*Cistecephalus* zone.)

Genus MYOSAURUS, gen. nov.

Myosaurus gracilis, gen. et sp. nov.

Two beautiful skulls form the co-types of this new genus. They are of the same size and were obtained from Harrismith, O.F.S., in the same calcareous nodule of Middle Beaufort age, in beds associated with numerous *Lystrosaurus* skulls. The form is allied to *Emydops*, but differs in being absolutely free of molar or canine teeth.

The following are the chief measurements:

Greatest length (oblique)	48 mm.
Greatest width	36 ,,
Interorbital width	11 ,,
Intertemporal width	17 ,,
Length of orbit	13 ,,
Width of orbit	12 ,,
Snout to front of orbit (oblique)	12 ,,
Width of palate	10 ,,
Basal length	40 ,,

The snout is feeble and narrow, and the nostrils are almost terminal. They are close together and look practically wholly forwards. At the front of the orbit the skull broadens rapidly. The orbit is

large and circular, and looks forwards, upwards and outwards. The postorbital bar is feeble. The temporal fossae are fairly long, and, on account of the breadth of the parietal region, look mainly outwards.

The premaxilla is very feeble, and apparently provided with a short internasal process.

The nasal forms most of the upper and half of the posterior borders of the nostril. It passes back along the top of the snout to meet the frontal in a long suture, and its lower edge articulates with the prefrontal, lachrymal, and maxilla. There is no septomaxilla visible.

The maxilla forms most of the small cheek. It passes back under the jugal not quite to the postorbital bar. The lower edge of the bone

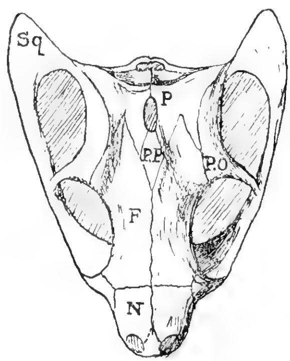

FIG. 41.—*Myosaurus gracilis*, Htn. Type. No. 3526. Natural size.

is very thin in the anterior half and the caniniform process extremely feeble—almost non-existent.

The lachrymal and prefrontal are both fairly small triangular bones whose bases form portions of the antorbital border.

The frontal is fairly broad and extends back to the level of the parietal foramen, *i. e.* half way along the parietal bar, forming there a wedge dividing the anterior part of the parietal into two portions. The orbital borders are not raised, and there are no supraorbital bosses.

I can find no evidence of a postfrontal. The frontal overlaps the postorbital from the orbital border back to the parietal.

The postorbital forms the whole of the upper and anterior borders of the temporal fossa. Its downward prolongation is weak, but it expands slightly at its articulation with the jugal.

The preparietal is a narrow rhomboidal bone extending from the parietal foramen to just in front of the plane of the postorbital arch.

The pineal foramen is far back on the broad parietal bar, its posterior end being only 2 mm. in advance of the occipital plate. From either side of the foramen a groove passes forward to the orbital border, the preparietal region and the lateral portions of the parietal bar standing out as prominences.

The parietal is a short, broad bone, an outer narrow prolongation passing between the postorbital, interparietal and tabulare. It forms no part of the border of the fossa. At the back of the parietal bar the bone is bent abruptly and lies vertically in front of the interparietal.

The occipital plate is broad and shallow and almost vertical. Its upper portion is formed by the broad interparietal, which has a

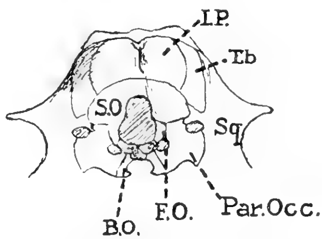

Fig. 42.—*Myosaurus gracilis*, Htn. Sketch of occipital plate. Natural size.

vertical median keel. Below the interparietal lies the supraoccipital, whose upper border is semicircular, and which forms the border of the upper half of the foramen magnum. Below it meets the exoccipital and the paroccipital, but takes no part in the border of the post-temporal fossa.

Lateral to the interparietal and the supraoccipital lies the tabulare, a long, narrow bone which extends down almost to the lateral vacuity, but which takes no part in forming the border of the vacuity.

The condyle is tripartite. The exoccipitals form the lateral portions, while the basioccipital forms the lower median third. This latter lies in advance of the exoccipital portions, so that the plane of the back of the condyle is inclined and not vertical. The exoccipital forms the half of the lower border of foramen magnum. It articulates laterally with the paroccipital, the two being separated by a well-defined suture.

The paroccipital is short and stout. It forms more than half the border of the lateral vacuity and also encloses most of the foramen jugulare. Below this foramen it articulates with the basioccipital.

The foramen jugulare lies below the level of the foramen magnum and looks downwards and backwards.

The palatal area is long and narrow, the basisphenoid region short and broad. The minimum width across the pterygoids is under 4 mm. There is a small but distinct transpalatine.

Types.—Two skulls in nodule. (S.A. Mus. Cat. Nos. 3526, 3526*a*.)

Locality.—Harrismith, O.F.S.

Horizon.—Middle Beaufort Beds. (*Lystrosaurus* zone.)

Genus PROLYSTROSAURUS, gen. nov.

Prolystrosaurus natalensis, gen. et sp. nov.

A skull from Loskop, Natal, is made the type of this new form. It was found in beds of undoubted Middle Beaufort age associated with typical skulls of *Lystrosaurus*. Details of the skeleton are obtainable from an almost complete specimen discovered by Dr. du Toit also at Loskop, the skull of which is slightly smaller and slightly different in shape from the type. Nevertheless, it is advisable to put the two specimens in the same species.

The skull is intermediate in form between the normal *Dicynodon* and the normal *Lystrosaurus*. The snout is bent down as in the latter genus but is not elongated to anything like the same extent. The interorbital region is broad, the intertemporal narrower. The nostril is large and the distance between it and the orbit short. The temporal openings are comparatively larger than in *Lystrosaurus*. The pineal foramen is oval, as in *Dicynodon*.

The following table gives the chief measurements of the skulls of the two specimens. It is probable that the type has been slightly flattened laterally.

	Type.	Co-type.
Greatest length (front of snout to squamosal)	110 mm.	118 mm.
Greatest width	85 ,,	105 ,,
Interorbital width	35 ,,	43 ,,
Intertemporal width	22 ,,	23 ,,
Length of orbit	36 ,,	38 ,,
Height of orbit	21 ,,	26 ,,
Height of suborbital border above edge of maxilla	41 ,,	45 ,,
Width between tusks	30 ,,	33 ,,
Length from snout to front of pineal foramen	57 ,,	57 ,,

The chief features of the skull can be seen from the figures given.

The premaxilla forms the whole of the lower and inner borders of the nostrils and covers the front of the snout, passing up as a wedge-shaped bone to lie in front of the nasals, appearing thus to separate them from each other for part of their length.

The maxilla is a square bone supporting the jugal below the orbit and carrying the tusk which passes downwards and appears below the front part of the orbit. No definite septomaxilla can be seen on the face, although it is probable that one is present.

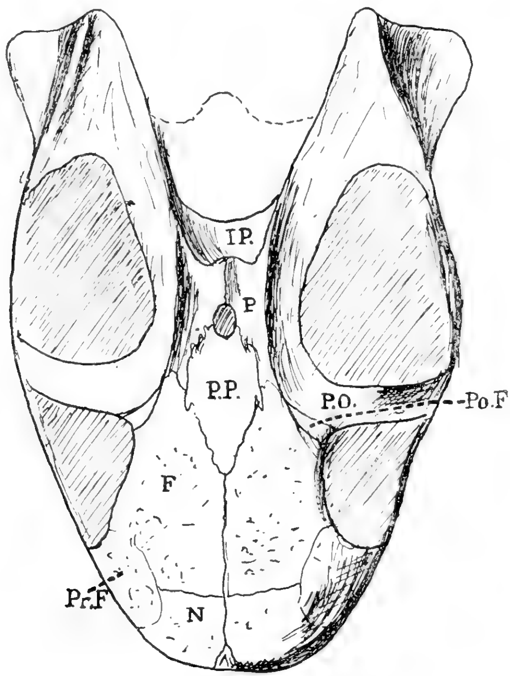

Fig. 43.—*Prolystrosaurus natalensis*, Htn. Type. No. 3715. × $\frac{3}{4}$.

The nasals form a straight suture behind with the frontals. Anteriorly they lie behind the premaxilla. They also form the insignificant nasal bosses. Their width is greatest in front, as posteriorly they are narrowed by the encroachment on the top of the snout of the prefrontal.

The prefrontal is large, the lachrymal smaller. The frontals are broad and do not pass behind the postorbital bar. The relations of the bones round the pineal foramen is shown in the figure.

The outer bar of the temporal vacuity passes backwards and inwards so that the greatest width across the skull is measured at the post-

orbital bar and not as in *Dicynodon.* The downward processes of the squamosals are also considerably expanded laterally.

The occipital plate slopes backwards, so that the basal length of the larger skull is 100 mm. The foramen magnum is fairly small, the condyle tripartite and large. The lateral vacuities lie far apart and at the level of the bottom of the foramen magnum.

The lower jaw is short and the mentum is far back, the beak sloping forwards gradually and fitting within the upper jaw.

Associated with the larger skull is most of the postcranial skeleton.

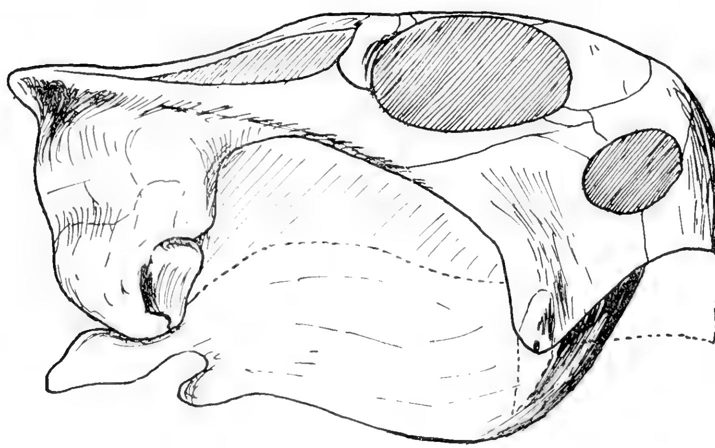

FIG. 44.—*Prolystrosaurus natalensis,* Htn. Type. No. 3715. × $\frac{3}{4}$.

Of the vertebral column there are 34 vertebrae preserved—25 cervical and dorsal, 6 sacral, and 3 caudal, The number of presacral and sacral vertebrae is similar to that given by Watson for *Lystrosaurus.* The total length of the column from the occipital condyle to the back of the posterior sacral is 410 mm.

The shoulder-girdle is almost entire. The sternum and interclavicle cannot wholly be seen, the clavicles are slightly displaced, and the right scapula has been crushed flat on to the ribs. The scapula is 85 mm. long, 45 mm. broad at the upper end, 25 mm. broad at the acromion process, and 35 mm. at the proximal end. The articular surface for the precoracoid is 21 mm. long. Anteriorly it narrows to a point, but posteriorly it is 17 mm. broad. The precoracoid is a rounded bone 25 mm. long and 27 mm. broad. It has a large notch on its upper border. Posteriorly it forms apparently a small portion of the glenoid

cavity. The coracoid is of the normal Anomodont type. The clavicles are slightly curved and are 77 mm. long.

The humerus is 85 mm. long, has a breadth at the head of 47 mm., a width at the distal end of 49 mm., while the shaft has a minimum width of 16 mm.

The radius is 54 mm. long, 18 mm. broad proximally, and 26 mm. broad distally. The bone is twisted so that the longer diameter of the distal end is not continuous with that of the distal end of the ulna, but is bent at an angle to it passing inwards and backwards.

The ulna is 57 mm. long, *i. e.* slightly longer in proportion to the humerus than in *Lystrosaurus.* As in that genus there is no bony olecranon process; but on the ulnar side of the facet for the humerus the top of the bone is broad and flattened, possibly for the support of cartilage acting as a cap. The maximum width at the proximal end is 19 mm., at the distal end 17 mm., and the minimum width across the shaft is 9 mm. The lower arm is carried at right angles to the upper arm.

Part of the right fore foot is preserved. The carpals are not ossified, but metacarpals I–III are there and some of the phalanges of the digits, which are twisted inwards. The preserved portion agrees closely with the hand of *Lystrosaurus* described by Watson (Geol. Mag., 1913, p. 256). The third metacarpal is larger than the second. The terminal phalanx of the thumb is a very broad, thin bone. The following are the measurements of the bones seen on the dorsal surface, in millimetres:

	Length.	Proximal breadth.
Metacarpal I	5·5	10·5
Phalanx I	9	11
,, II	12	12
Metacarpal II	11·5	14
Phalanx I	7	12
,, II	9	11
Metacarpal III	14·5	14·5
Phalanx II	6	11
,, II	7·5	11

The ilium has a large preacetabular portion as in *Lystrosaurus*, but is somewhat higher than in that genus. Its upper border carries two notches, corresponding to the posterior two of the three figured by Watson. The total length of the bone is 88 mm., the greatest height 63 mm., and the width at the acetabular end 30 mm. Compared with *Lystrosaurus* the upper border of the bone ascends more rapidly from the postacetabular process to the highest point.

Neither ischium is complete, but the bone is greatly produced backwards. The pubis is not seen.

The femur is 95 mm. long, has a narrow proximal width of 40 mm., and a distal width of 31 mm. The shaft has a minimum width of 16 mm. The median condyle is somewhat smaller than the lateral, and the medial surface of the bone is produced lower than the lateral. The groove between the condyles on the posterior face is a little deeper than that on the anterior.

Of the lower part of the limb only the proximal half is preserved. The tibia has a strongly expanded end. The fibula is a slender bone expanded proximally.

This form may be considered as a link between *Dicynodon* and *Lystrosaurus*, approaching the latter rather closely. It has close affinities with the form from Harrismith described by Broom as *Dicynodon strigops*, but is at least specifically distinct in the fact that the plane of the snout is at right angles to the fronto-parietal plane and not inclined at 45°. Moreover, the anterior border of the orbit is rounded and not angular. These differences I am inclined to consider specific and thus place Broom's species in this new genus under the name *Prolystrosaurus strigops* (Broom).

It is possible that the bending down of the snout and lengthening of the premaxilla and maxilla which must have taken place in the evolution of *Lystrosaurus* from the earlier Anomodonts is foreshadowed in such a form as *Dicynodon testudirostris* from the *Cistecephalus* zone. At the same time as the lengthening of the prenasal portion of the snout took place there was a broadening of the frontal region and a shortening of the temporal openings. In these features *Prolystrosaurus* agrees with *Lystrosaurus*; and the discovery of further forms from the upper part of the *Cistecephalus* zone may enable us to trace out gradual changes between *D. testudirostris* or some similar form and *Lystrosaurus* through *Prolystrosaurus*.

Type.—Skull and lower jaw. (S.A. Mus. Cat. No. 3715.)

Co-type.—Skull, lower jaw, and nearly complete skeleton (331*g*).

Locality.—Loskop, Natal.

Horizon.—Middle Beaufort Beds. (*Lystrosaurus* zone.)

Prolystrosaurus strigops (Br.),

1913. Broom, *Dicynodon strigops*. Rec. Albany Mus., ii, 5, p. 400.

1915. Broom, *Dicynodon strigops*. Bull. Amer. Mus. Nat. Hist., xxv, 2, p. 140; fig. 29.

Skull rather small. Skull unusually flat, orbits directed more

upwards than outwards; tusks passing as much forwards as downwards. Beak elongated, upper surface at 45° with frontoparietal plane. Anterior side of orbit comes to an angle of 70–80°. Parietal region 23 mm. broad, frontal 33 mm. Large preparietal. Pineal foramen bounded by parietals on the side and by preparietal in front. Parietals unusually large. No opisthotic.

Type in the American Museum of Natural History.

Locality.—(?) Harrismith, O.F.S.

Horizon.—Middle Beaufort Beds. (*Lystrosaurus* zone.)

Genus KANNEMEYERIA, Seeley.

Kannemeyeria erithrea, Htn.

1915. Haughton. Ann. S.A. Mus., xii, 3, p. 91; figs. 12–14.

Kannemeyeria is the large Dicynodont which occurs in the Upper Beaufort Beds. The skull is characterised by the high, narrow, convex parietal crest which rises well above the interorbital plane, the broad frontal region, the strongly ridged and rugose snout, and the large nostrils. In these features it resembles to some extent *Dicynodon grandis*, *Eocyclops*, and similar large forms from the *Cistecephalus* zone, and also some of the species of *Endothiodon*. From the large Lower Beaufort Dicynodons it differs in the size of the temporal openings and in one or two other details. The parietal crest is more pronouncedly convex. From *Endothiodon* it differs, of course, in the lack of molar teeth.

The beautiful skull which forms the type of this species has been described fairly fully as far as the external features go. It does not show clearly whether a preparietal is present, but a second fragmentary skull from the type locality seems to indicate that a small preparietal formed the anterior border of the pineal foramen. The foramen lies in a deep excavation as in *Dicynodon grandis* and on one side of the wall of this hollow two sutures can be seen joining in front of the level of the pineal foramen, forming presumably the borders of an anterior wedge of the parietal lying on one side of the median preparietal.

This same fragmentary skull has been sectioned longitudinally and the brain-case between the foramen magnum and the opening for the 5th nerve cleaned. The cranial cavity is higher than wide. The basioccipital and basisphenoid are thick bones even in the middle line; and the basioccipital tubera lie considerably below the level of the

midline of the basicranium. The floor of the brain-case is horizontal in front of the foramen magnum with a median swelling flanked by a slight groove on each side. Just in advance of the inner opening for the 12th nerve the floor dips suddenly, and then rises as suddenly to the opening for the 7th nerve. The sides of the brain-case are vertical.

All the foramina for the nerve-exits are low down in the cavity. They agree closely in position with those figured by Broom for *Dicynodon* (Proc. Zool. Soc., 1912, Pl. LVI). Between the small opening for the 12th nerve and the larger one for the 9th–11th nerves there is a broad transverse ridge of bone which crosses the floor of the cranial cavity. The opening for the 9th–11th nerves is connected with the upper end of the vestibule by a narrow groove. The upper end of the vestibule is in a pit in the floor and lies considerably lower than the other openings. The opening for the 7th nerve is small. The vestibule for the ear was very long, but nothing can be seen of the osseous canals.

Type.—Skull and lower jaw. (S.A. Mus. Cat. No. 3017.)

Locality.—Winnaarsbaaken, Albert, C.P.

Horizon.—Upper Beaufort Beds. (*Cynognathus* zone.)

Kannemeyeria latifrons (Br.).

1899. Broom, *Dicynodon latifrons.* Ann. S.A. Mus., i, p. 452; pl. x, figs. 1–3.

Founded on an imperfect and crushed skull. Maxillary breadth just larger than frontal breadth. Orbits directed laterally. Frontal region broad and flat. Nasals greatly developed. Parietal crest narrow. Parietal region inclined obtusely to the frontal. Pineal foramen placed just behind postorbital bar. No postfrontal. Apparently no preparietal. Frontal width four times as great as the intertemporal. Postorbitals do not touch one another. Skull deeply hollowed in front of the pineal foramen.

Type in the Port Elizabeth Museum

Locality.—Burghersdorp, C.P.

Horizon.—Upper Beaufort Beds.

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EXPLANATION OF PLATES XVI—XVIII.

PLATE XVI.

Dicynodon grandis, Htn.

Fig. 1.—Upper view of type skull. × $\frac{1}{5}$ nearly.
Fig. 2.—Side view of type skull. × $\frac{1}{5}$.

PLATE XVII.

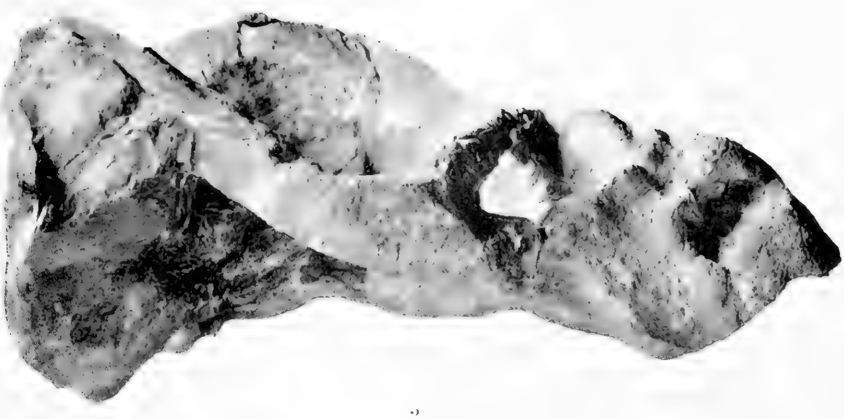
Eocyclops longus, Br.

Fig. 1.—Upper view of skull. S.A. Mus. No. 3425. × $\frac{1}{4}$ nearly.
Fig. 2.—Side view of skull. S.A. Mus. No. 3425. × $\frac{1}{4}$ nearly.

PLATE XVIII.

Upper view of skeleton of *Prolystrosaurus natalensis*, Htn. × $\frac{1}{4}$.

1



2

DICYNODON GRANDIS, HAUGHTON.

Adlard & Son & West Newman, Ltd.

1

2

EOCYCLOPS LONGUS, Broom.

Adlard & Son & West Newman, Ltd.

PROLYSTROSAURUS NATALENSIS, Haughton.

Adlard & Son & West Newman, Ltd.

15.—*Investigations in South African Fossil Reptiles and Amphibia* (Part 11).—By S. H. HAUGHTON, B.A., F.G.S., Assistant Director.

11.—Some New Carnivorous Therapsida, with Notes upon the Brain-Case in Certain Species.

THERAPSIDA.

MACROSCELESAURUS JANSENI, n.g. et n.sp.

During the year 1917 the Museum became possessed, through the generosity of Mr. F. J. Jansen, formerly Resident Magistrate of Victoria West, of a slab of sandstone showing the impression of the almost complete skeleton of a small reptile. The slab was found built into the wall of a kraal at Gemsbokfontein, 12 miles from the town of Victoria West, and there is no reason to suppose that it had been brought from any place other than the nearest sandstone ridge on the farm Gemsbokfontein. The known fossils from the Victoria West District are few in number, and seem to consist in the main of types not hitherto known from other parts of the Karroo Beds, and this fossil therefore is of some interest.

Unfortunately, all the bone substance is weathered away, and the mould in the sandstone which remains is not very clear-cut; and, in addition, the majority of the skull is altogether missing. What is seen is a mould of the ventral side of the skeleton. The backbone is curved; both fore-limbs are thrown to the right hand side and are bent; and the hind limbs are flexed at the knee, the femora lying thrown forward.

Of the skull but little remains. The head was obviously triangular and sharply pointed in front. The teeth were small and differentiated. There are remains of a canine and 8 molars in the maxilla, the canine being preceded by small incisors, of which the last, at least, remains. The canine is a larger tooth than the others, and is set outside the line of the molars, so that the skull must have had a considerable swelling at the level of the

canine—or, in other words, the snout was constricted behind the canine. Each tooth is elliptical in section, the somewhat longer axis lying in the line of the jaw. The longer axis of the cross-section of the canine is 3.5 mm. long, while the first 7 molars occupy a length of 11 mm.

In the right ramus of the lower jaw 8 molars are to be seen, each placed directly beside the corresponding tooth of the upper jaw, the teeth of the maxilla biting outside those of the dentary. The point of the tooth is bluntly rounded, and not sharply pointed. It is probable that there were 3 or 4 more molars present in the complete set. The posterior molars are slightly smaller than the anterior ones in both upper and lower jaws.

There is a faint impression of one of the bones of the palate on the right side having a curved outer border ; the bone is probably the palatine, forming the inner border of an oval suborbital vacuity. As preserved the skull is 56 mm. long ; but it was probably somewhat longer when complete. The front of the lower jaw was narrow, fairly high, and sloped backwards.

The neck has almost disappeared ; only traces of the cervical vertebrae can be seen, with the exception of the last. The neck was fairly long and contained apparently 7 vertebrae. The whole skeleton lies in position, and there seems to have been no displacement of the neck. If this supposition of 7 cervicals be correct then there are in all 27 presacral vertebrae. The centra of the cervicals are longer than those of the dorsals. Every centrum is constricted in the middle and expanded at the articular ends. In the last cervical the centrum has a longitudinal ventral median keel ; in the dorsals the ventral surface is rounded and very slightly flattened. All the dorsals are very similar in size. None of the vertebrae show the transverse processes or the zygapophyses. Judging from the position of the ribs, the transverse processes were fairly short. There are no intercentra present, nor is it likely that any occurred in life ; the articular surfaces of the centra show no bevelling on the ventral side.

There are three coalesced sacral vertebrae, of almost the same size as the presacrals. The centra are rounded on their under surface. The last cervical is 7 mm. long. The 3rd dorsal centrum is 6.5 mm. long and has a maximum width of 6 mm. The three sacrals are 6 mm., 6.5 mm., and 6.5 mm. in length respectively ; the anterior end of the first is 7.5 mm. wide.

All the presacral vertebrae carry ribs. The presacral ribs are possibly double-headed ; the articular end is long and broadened. The ribs are long, slender, and curved ; their ventral surface is longitudinally grooved. The anterior sacral rib is strong and fairly long. It arises from the anterior portion of the centrum and is directed strongly backwards. It has a swollen end for articulation with the ilium. Only a very small portion of the

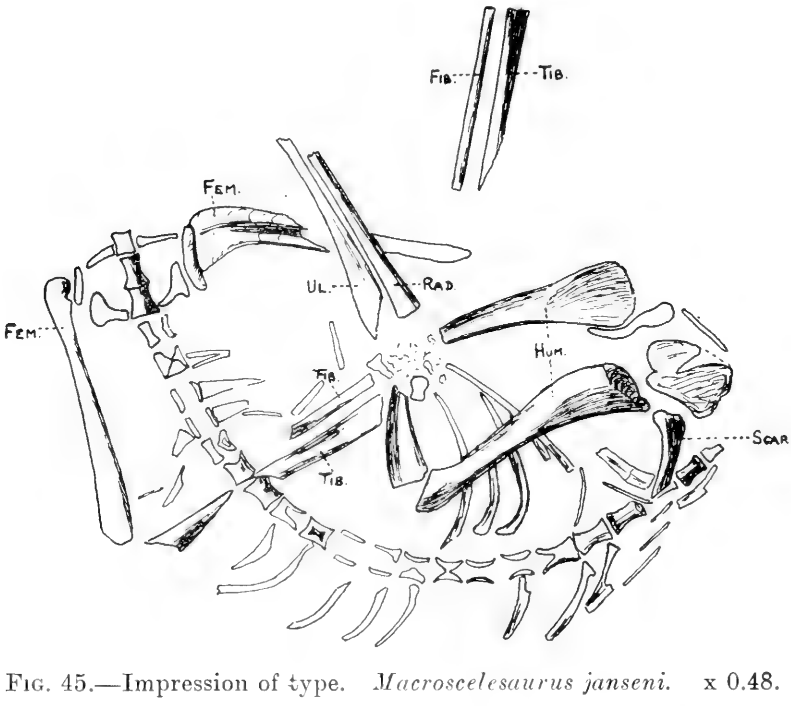


Fig. 45.—Impression of type. *Macroscelesaurus janseni.* x 0.48.

2nd sacral is preserved ; it was very much more slender than the first, but articulated with the ilium. The 3rd sacral rib is a fairly slender rib arising on the anterior half of the centrum and directed outwards and slightly forwards to articulate with the ilium. Its distal end is in contact with that of the 2nd sacral rib. There is no evidence of abdominal ribs.

The pectoral girdle is not well preserved and the details of the structure are difficult to determine. The scapula is only seen in its lower half. It has a fairly narrow shaft and a broad proximal end, but apparently had no distinct acromion process. The precoracoid is partially seen. It is a medium-sized bone with a

rounded anterior border; there is in all probability a small rounded foramen lying near the suture with the coracoid. The bone takes no part in the formation of the glenoid cavity, which is bounded wholly by the scapula and the coracoid. The anterior half of the coracoid only is seen. The border is notched just below the glenoid cavity. A piece of rod-like bone lying near the coracoid is probably a portion of the clavicle.

The humerus has a length of 60 mm. The delto-pectoral crest is not strong, but it extends nearly half-way down the bone. The proximal half is somewhat broadened and is 15 mm. wide at its broadest. The upper border of the articular end is bowed, and there is a slight swelling at the head. The shaft of the bone is slender, and the distal end slightly expanded.

The radius and ulna are both long, slender bones, very slightly expanded at the ends. The ulna is 57 mm. long, and the radius possibly 1 mm. shorter. The former has no olecranon process. Both bones are nearly straight. The proximal surface of the radius was slightly cupped. Distally the radius is somewhat more expanded than the ulna. Nothing can be seen of the carpus or manus.

The pelvis was broad. The pubis and ischium, although present, have not been developed; they were probably of the plate-like type. The ilium had a pronounced posterior process which extended some way behind the articulation with the 3rd sacral rib. The upper border of the ilium was probably about 20 mm. long. The distance between the inner surfaces of the ilia is 27 mm.

The femur is long and slightly curved, with a maximum length of 71 mm. The ends are not much swollen. The tibia and fibula are long, slender bones, almost straight, with slightly expanded ends. The tibia is stouter than the fibula. Each is as long as, or slightly longer than, the femur.

Portion of the left tarsus is preserved. The fibulare is a larger bone than the tibiale. Its proximal articular surface is strongly concave, the outer edge being higher than the inner. The tibiale articulates closely with the fibulare on the outer surface except that between them in the distal half is a circular foramen such as is seen in *Broomia.* The other elements are difficult of determination. In the tarsus there seems to be a distal row of tarsalia, and one centrale, lying distal to the tibiale. The remainder of the foot is lying below the impression of the fore-limb and so cannot be developed.

From its general features this form seems to have affinities with the Dromasauria, but it certainly differs from any of the described forms. The most noticeable feature is the length of the limbs, of which the hinder are considerably longer than the front legs. In *Galechirus scholtzi* the femur is only slightly longer than the humerus; in *Galepus* no measurements of the femur have been given; and in *Galeops* it is unknown. In all these forms, moreover, the humerus is much longer than the radius and ulna, while in the new form the upper arm is roughly the same length as the lower arm.

The presence of a distinct enlarged canine brings the form nearer to the Therocephalia than to the Dromasauria. The absence of intercentra in the dorsal region is a feature shared with the Dromasauria and other Therapsida. The pectoral girdle, as far as can be seen, shows no difference from those of the Dromasauria. There is the same absence of a distinct acromion, the same two large coracoidal elements. The humerus is of somewhat different form. The delto-pectoral crest extends further down the shaft than in *Galepus* or *Galeops*. The absence of an olecranon process to the ulna is paralleled in *Galechirus*. The sacrum is not known in any of the hitherto-described Dromasauria. The posterior process to the ilium is seen in *Galepus*. The structure of the tarsus is also typically Dromasaurian as far as can be seen. It must be noted, however, that some of the features—such as the presence of two coracoidal elements and the possible tarsal structure—in which this form parallels the known Dromasauria are primitive features common to most of the South African Therapsida. Indeed, the differences between the postcranial skeleton of this form and that of the Therocephalia such as *Ictidosuchus*—as far as the latter group is known—are not very striking; and the nature of the dentition allies the form to the Therocephalia.

The other long-limbed South African Permian reptiles are *Heleosaurus*, *Heleophilus*, *Broomia*, and *Mesosaurus*. With none of these is the form so closely allied as it is with the Dromasauria and the Therocephalia, and it may be concluded that it is a Dromasaurian specialised in the development of the limbs for swift movement over the ground and akin to the Therocephalia in the specialisation of the teeth. In the absence of a well-preserved skull, however, it is impossible to dogmatise upon the systematic position of the form.

It would seem advisable, therefore, in the absence of definite correlation with any hitherto-described forms, to make the form the type of a new genus which can be called *Macroscelesaurus*, with the full name of *Macroscelesaurus janseni* in honour of the gentleman who transferred the specimen from a sheep-kraal wall to the Museum collection.

Type.—Sandstone slab with almost complete skeleton (in mould) S.A.M. Cat. No. 4004.

Locality.—Gemsbokfontein, Victoria West, C.P.

Horizon.—Lower Beaufort Beds (*Tapinocephalus* zone ?).

Alopecognathus minor, n.sp.

The following description is based upon the almost perfect skull of a medium-sized Therocephalian found by the Rev. J. H. Whaits at Klipbank Siding, south-west of Beaufort West, in beds which belong to the upper part of the *Tapinocephalus* zone. The matrix is extremely hard, but it is possible to clear the bone, and I have been able to discern most of the features of the occiput and basicranium as well as of the upper part of the skull.

The skull is long and narrow, the orbit lies in the middle of the skull, the parietal crest is narrow and fairly high, and the dental formula of the upper jaw is i6c1m4. The skull, in its general appearance and in the possession of 6 incisors, displays affinities with *Alopecognathus angusticeps*. There are four molars in the skull under description instead of six, the eyes are placed further forward, and there are differences in the relative positions of the teeth. Of the basicranial region of *Alopecognathus angusticeps* no description has been given. In spite of the differences mentioned I deem it advisable to keep the two forms in the same genus, and I propose for the new form the name *Alopecognathus minor*, sp. n.

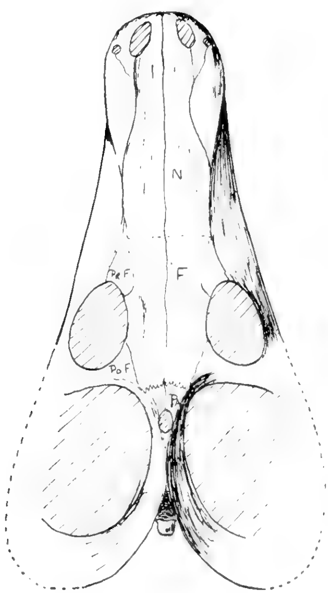
The premaxilla is small, and carries 6 incisors which occupy a space of 31 mm. The 5th and 6th incisors are slightly smaller than the others.

The single large canine lies 10.5 mm. behind i6, and has a diameter of 12 mm. Then follows a diastema of 8 mm., behind which are 4 small molars occupying 26 mm. The molars are short, but robust, and flattened. All the teeth were probably finely serrated along their posterior borders, the incisors and molars certainly so.

The snout is bluntly rounded. The nostrils are almost terminal, and look nearly entirely upwards. They are longer than wide,

and the anterior ends approximate to one another. The whole of the lower border is formed by the septomaxillary which also forms the upper border of the small external foramen, and passes back some distance behind the nostril.

The maxilla is long and narrow. The nasal is long and comparatively narrow, broader at its two extremities than in the middle. Posteriorly the two bones are separated for a short distance by the frontals.



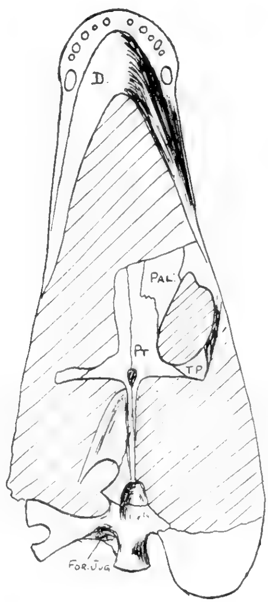


FIG. 46.—Upper view of type skull of *Alopecognathus minor*. x $\frac{1}{3}$.
FIG. 47.—Ventral view of type skull of *Alopecognathus minor* as developed. x $\frac{1}{3}$.

The prefrontal is fairly large; the lachrymal smaller. There is a pronounced antorbital depression.

The orbit is longer than wide, almost wholly in the posterior half of the skull. The postorbital arch is comparatively weak.

There is a pronounced triangular-shaped postfrontal. The postorbital does not pass far along the upper border of the temporal fossa, most of the border being formed by the parietal.

There is a large pineal foramen 10 mm. behind the postorbital arch, wholly surrounded by the parietals There is no preparietal

Unfortunately the sutures of the occiput are not clearly shown, but some points in the structure can be discerned. The basioccipital condyle is large and rounded, and projects considerably behind the occipital plate. The lateral margin of the foramen magnum is formed by the exoccipital, which also forms the upper margin of the foramen jugulare. The exoccipital is a larger bone than that described by Watson in the Gorgonopsians *Arctops* and *Scymnognathus.* The two exoccipitals do not meet, but the upper border of the foramen magnum is formed by the supraoccipital. The post-temporal fossa is of moderate size, on a level with the foramen magnum. The bone which forms almost the whole of its upper border is, I think, the supraoccipital, which is very wide and comparatively shallow. Superiorly there is a pronounced horizontal backward extension of the squamosal, so that the tabulare is hidden when the skull is viewed from above. This bone, the limits of which I cannot determine, lies laterally to the supraoccipital and forms part, at least, of the outer border of the post-temporal fossa. In the Therapsida as far as it has hitherto been described it almost invariably extends down outside this fossa to meet the paroccipital process; but the lower limit in this form is indefinable. It is very doubtful, however, whether the tabulare and the paroccipital process meet. The paroccipital process is a stout, high bone forming the whole of the lower border of the post-temporal opening. Externally it articulates for most of its height with the squamosal. Internally it meets the exoccipital and the basioccipital. The extreme inner and front corner of the bone forms part of the border of the fenestra ovalis. The paroccipital process has a considerable forward extension laterally, and the outer part of its under surface has a groove ending in what is apparently a foramen between this bone and the squamosal.

The fenestra ovalis is a medium-sized hole, apparently not bounded by bone on its outer side. Its outer posterior border is formed by the paroccipital process, the anterior half of the border is formed by the basisphenoid tuber and the prootic, and the remainder by the basioccipital. It lies well in front of, and a little below, the basioccipital process.

Seen from below, the anterior part of the basioccipital between the fenestrae ovales is strongly concave, and the median depression is continued forward to the basisphenoid. Anteriorly it ends abruptly and gives place to a deep and narrow median basisphenoid

keel formed by the junction of the ridges from the tubera, and having its lower border considerably below the level of the basioccipital condyle. This condition is also seen in the primitive Gorgonopsian *Arctops* and in the Therocephalian *Scymnosaurus watsoni*. The basisphenoid keel passes forward almost to the lateral process of the pterygoid, lessening in height anteriorly and being clasped anteriorly and superiorly by the vertical pterygoid plates.

On the median line these pterygoid plates pass back almost to the level of the back of the basisphenoid keel. They are at first vertical, then turn outwards and finally downwards, so that in section they have the appearance of a curved arch. The outer ramus passes back presumably to the quadrate.

In front of the basisphenoid keel there is a narrow, somewhat elongate pterygoid vacuity, at the sides of the back of which the powerful pterygoid flanges pass out to meet the transpalatine. The transpalatine is comparatively small.

There is a fair-sized suborbital vacuity. The inner posterior border is formed by the pterygoid, which passes forward with the same relation to the palatine as in *Scymnosaurus watsoni*. I am not able to distinguish a median vomer. The pterygoid has a small ridge bearing a few teeth.

The front of the palate is not displayed, but it is probably typically Therocephalian in structure. Its chief feature is its great length compared with the breadth; in fact, the whole palatal aspect is long and narrow.

The lower jaw is practically complete. The symphysis is loose and low, the front of the jaw rapidly retreating. There is a large and wide coronoid process to the dentary. The angular is large and passes well forward to below the middle of the orbit. The splenial plays no part in the symphysis.

The following are some of the chief measurements of the type specimen :—

Greatest length	240	mm.
Greatest width .. .. .. (about)	110	,,
Snout to front of orbit	111	,,
Interorbital width	30.5	,,
Intertemporal width	11.5	,,
Length of temporal opening	58	,,

Type.—Skull and lower jaw (S.A.M. Cat. No. 3415).

Locality.—Klipbank, Beaufort West Division, Cape Province.

Horizon.—Lower Beaufort Beds (*Tapinocephalus* zone.)

Whaitsia platyceps, gen. et sp. nov.

The extremely interesting type described here is founded on two skulls collected by the Rev. J. H. Whaits at Zuurpoort in the District of Graaff-Reinet, C.P., at a height of 4,000 feet above sea-level, and is therefore probably from the middle or upper part of the *Cistecephalus* zone of the Lower Beaufort Beds. One skull has suffered lateral pressure; the other—a more perfect one—has been slightly flattened from above. The latter—No. 4006, S.A. Mus. Catalogue—may be taken as the type; the other—No. 4330—as the co-type.

In external appearance the skull might be mistaken for that of a fairly broad-snouted Cynodont. The nostrils are small, almost terminal, and look mainly forwards. The snout is rounded at the end, broad, flat, and of a medium length. The orbits are small and widely separated. The temporal openings are very large and the parietal region is narrow, crested as in the Cynodonts and Therocephalia and not broadened as in the Bauridae and Gorgonopsia.

The maximum length of the type skull was about 280 mm., the maximum width about 220 mm. The interorbital width is 66 mm.

The internasal septum is formed in the lower half by the premaxilla and in its upper half by the nasals. The premaxilla forms the lower border of the nostrils. In the type the premaxilla carries no teeth, with the possible exception of one fragment on the right-hand side; but in the co-type there are 4 incisors on each side—of which the first three are equal in size, the 4th smaller. The roots are long; the crowns were apparently long and sharply pointed, but not serrated.

The top of the snout is formed almost entirely by the nasals. These are broad anteriorly, contract in the middle where the maxilla encroaches on the top of the skull, broaden again, and then narrow to their junction with the frontals. There is a small boss above the outer side of the nostril which may be formed by a septomaxilla as in the Gorgonopsia, but the limits of the bone, if present, are not seen. External to the nostril are two foramina corresponding in position to the foramen found in the Therocephalia and Gorgonopsia.

The maxilla forms the side of the snout, extends below the jugal to the level of the postorbital bar, and in its posterior half

has a gradually widening broad palatal portion. Anteriorly it carries a large canine tooth which does not fill the alveolus; but behind the canine I can see no trace of any molar teeth nor of alveoli for such teeth in either skull.

The prefrontal is large and forms a large portion of the upper border of the orbit. The frontal is fairly short and seems to form portion of the supra-orbital border and meet the postorbital

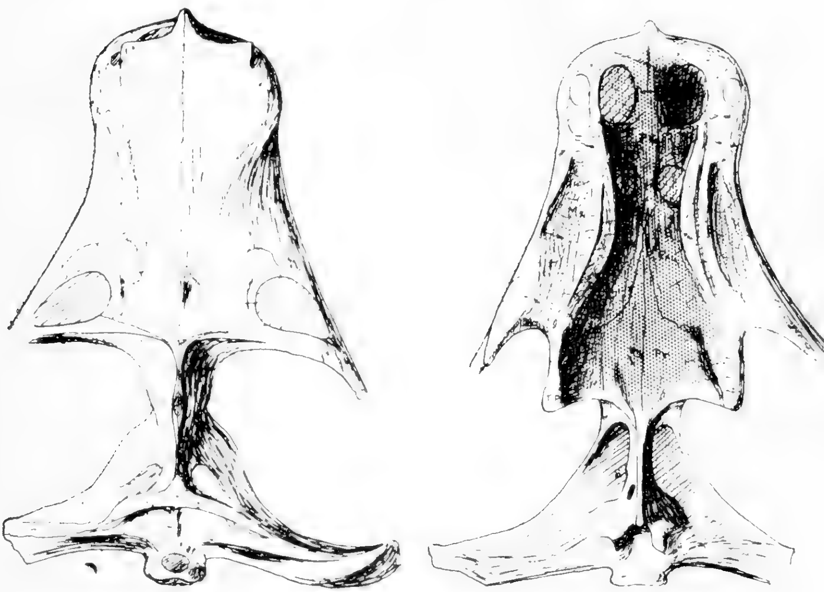


Fig. 48.—Upper view of type skull of *Whaitsia platyceps.* x $\frac{2}{7}$.
Fig. 49.—Ventral surface of type skull of *Whaitsia platyceps.* x $\frac{2}{7}$.

posteriorly. It may be, however, that part of the bone is in reality postfrontal. There are several irregular sinuses and pittings in the bone, but no definite suture is visible. If this be so, then the condition of the frontal would be similar to that in the Gorgonopsia.

There is no preparietal.

The postorbital bar is long and the postorbital extends some distance along the parietal crest, being interlocked with the parietal. This crest is narrow as in the Therocephalia and the Cynodontia. There is an elongate pineal foramen 25 mm. behind the postorbital bar.

The parietal forms the main portion of the parietal crest and is almost entirely a vertical bone. Lying behind it on the occipital plate is a large interparietal which articulates below with the supra-occipital and laterally with the tabulare.

The jugal forms the lower border of the orbit and extends back to meet the squamosal.

The occipital condyle is large and moderately thick and does not extend very far up the sides of the foramen magnum. It is shallower than that of *Arctops* and thicker than that of *Scymnognathus* figured by Watson. It is not certain to what extent the exoccipitals participate in the formation of the condyle, but certainly it is for the most part formed of the basioccipital.

The exoccipital differs from that of *Arctops*—it is a small triangular bone forming the upper border of the foramen jugulare and lying behind the paroccipital process. It plays no part in the boundary of the post-temporal fossa, and is well marked off from the paroccipital process.

The suture between the basioccipital and basisphenoid can be seen about 31 mm. in advance of the back of the condyle. The mass of the basisphenoidal tubera, which are not extremely large although quite prominent, is formed by the basioccipital, the basisphenoid lying below as in the Dicynodonts. Between the tubera the basioccipital is flat. Laterally the bone presumably articulates with the opisthotic, but the suture is not visible.

The foramen jugulare lies at a level just above the bottom of the condyle and faces entirely backwards. Its upper border is formed by the exoccipital, but in the main it lies in the paroccipital, whose posterior face is hollowed out horizontally on the outer side of the foramen.

The post-temporal fossa lies at the level of the middle of the foramen magnum; consequently the paroccipital, which is long, is more massive than in *Scymnognathus whaitsi* and less so than in *Arctops*.

The fenestra ovalis is an irregular-shaped opening, unbounded by bone on the outer side and lying some distance out from the basisphenoidal tubera, below the level of the occipital condyle.

Just in front of its suture with the basioccipital the basisphenoid forms a strong median keel which is continued forwards between the pterygoid vacuities by the pterygoids. The exact junction between the basisphenoid and the pterygoids is difficult of determination on account of fracturing in this region; but the

posterior part of the ridge—presumably basisphenoid—is pierced on either side by a large foramen, the upper border of which seems to be formed by the periotic. This is presumably the fossa identified by Watson in *Diademodon* as the pituitary fossa. A fracture across the basisphenoid of the co-type just in front of the median ventral ridge shows that the dorsal surface of the bone is broadly rounded.

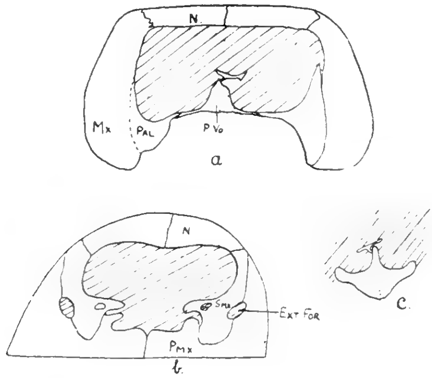
The pterygoid is a large bone attached to its neighbour throughout its length except where it forms part of the median keel, where the two are separated by the anterior portion of the basisphenoid. There is no interpterygoid vacuity. In front of the median keel the bones form a broad plate which is hollowed out in the middle. This hollowed portion occupies the position which is taken up by the vomer in the Gorgonopsia and the Cynodontia ; but here are no sutures to divide this portion from the rest of the pterygoid, and the vomer, in consequence, seems to play no part in the formation of this part of the palate. Moreover, the suture between the two pterygoids can be traced almost throughout the length of the plate-like portion.

Laterally the pterygoid articulates with the transpalatine. It forms the anterior boundary of the pterygoid vacuity and also thickens to form the fairly small downward process or pterygoid flange. The lower surface of this flange, however, is formed entirely by the transpalatine.

Anteriorly, the pterygoid narrows and passes forward as a narrow bar between the palatines to meet the prevomer. The lateral posterior ramus of the pterygoid passes outwards towards the quadrate and lies in front of a thin inwardly-directed process of the squamosal. A section across this ramus in the co-type shows the ramus lying below a thin plate of bone with which it is slightly interlocked. This thin plate is presumably part of the quadrate. The pterygoid is separated fairly widely from the paroccipital. Attached to the outer side of this ramus is the epipterygoid or columella cranii. This is a broad bone lying pressed against the pterygoid below and the parietal above. Its upper articulation is long ; its anterior upper end lies considerably in advance of the lower end ; and its anterior border is concave. Posteriorly its lower half extends far back, while the upper half articulates with the periotic. The bone occupies the same position and is of similar shape to the pterygoidal portion of the side-wall of

the brain-case figured by Watson in *Diademodon ;* but it differs in being obviously marked off by suture from the pterygoid. Broom figures the same bone as the alisphenoid.

The transpalatine articulates anteriorly with the palatine and maxilla and medially with the pterygoid. In the suture between the pterygoid and transpalatine there is a very small pit which may be looked upon as the relic of the suborbital vacuity of the Therocephalia.



WHAITSIA PLATYCEPS Htn.

FIG. 50a.—Transverse section just behind "transverse bar" of type.

FIG. 50b.—Section across distorted snout of co-type.

FIG. 50c.—Section of prevomer just in front of "transverse bar" in type.

The palatine articulates with the maxilla laterally, with the pterygoid medially, and anteriorly it meets the prevomer. The larger portion of the bone is vertical. Laterally it has a narrow horizontal portion lying alongside the maxilla and approximating to the bone on the other side to foreshadow the formation of a secondary palate. Then it bends abruptly at right angles, especially in its anterior half, and is again bent to form with the pterygoid and prevomer a plate considerably higher than the level of the edge of the maxilla.

The palatal portion of the maxilla broadens rapidly behind the canine and passes back to form part of the anterior border of the pterygoid vacuity. Its outer process lies under the jugal, which bone is completely shut out from articulation with the pterygoid by the maxilla and the transpalatine.

The prevomer forms part of the anterior median bar and lies between the palatine process of the premaxillae and the anterior portions of the pterygoids. In shape it is cruciform, the transverse arms forming with the palatines a bar separating two vacuities in the anterior part of the palate. Posteriorly it unites with the pterygoid. In cross-section just behind the transverse portion the prevomer is seen to be a triangular bone with its apex above, and undivided by any median suture. Superiorly it supports a thin plate of bone which has been crushed in the specimen. This thin plate passes back to meet the upper portion of the pterygoids —the exact method of articulation is not perceptible.

There are no palatal teeth, nor does the palatal surface of the maxilla carry any molars.

The palate shows many features of interest, and is seen to differ considerably from any described South African form. In the first place there are the two anterior vacuities to be accounted for. Fortunately it has been possible to develop the type specimen fairly completely, and the main structure can be ascertained. The median bar lies considerably above the level of the dentigerous border of the premaxilla and the palatal portion of the maxilla; in fact, the front of the palate is highly vaulted. The inner border of the anterior vacuity is formed by the premaxilla and the prevomer—the median bar. On the palatal surface half of this bar is formed by the prevomer; but on the nearly vertical side of the bar the premaxilla plays by far the major part. The side wall of the bar does not ascend to the roof of the skull, but stops abruptly about half-way between the palate and the under side of the roof. The front border of the cavity is formed by the premaxilla, the outer border by the maxilla, the posterior border by the palatine and prevomer, and it is roofed by the cranial bones of the region of the nostril. Into this cavity the outer foramen, seen lying external to the nostril in outer view, leads directly.

The posterior cavity is bounded by the transverse bar anteriorly, by the palatine laterally, and the pterygoid and prevomer medially. A vertical section fortunately obtainable shows that the two cavities—anterior and posterior—are connected with the external nares. The "transverse bar" has its upper surface sloping downwards and backwards, forming what seems to be the floor of the narial passage, leading one to conjecture that the posterior vacuities are the internal nares. The anterior cavity must then be the anterior palatine foramen (*foramen incisivum*). Although

the prevomer, the palatine, and the premaxilla each plays a small part in the formation of its border, it is mainly surrounded by the premaxilla. It is very large, the size being its most striking feature. It leads directly up into the nasal cavity. A section across the snout of the co-type shows that the nostril is divided into two unequal parts by a nearly horizontal turbinal, probably formed by a process of the septomaxilla. The upper portion is very much larger than the lower, whose floor is concave with a slight median ridge formed along the junction of the dorsal surfaces of the two premaxillary bones. The evidence seems to connect the lower portion with the anterior vacuity of the palate, while the upper part—the true nostril—is connected by a more gradually sloping tube with what has been identified as the internal narial opening.

Hitherto, the anterior palatine vacuity has been observed in very few Therapsids, and never to the extent displayed here. Broom (1911) mentioned its occurrence in *Gomphognathus*, and says " In the anterior palatine vacuity there is a pair of narrow bones showing what I suggested a good many years ago were probably prevomers." Here the opening seems to have been a single median one ; its size is not mentioned, and it is not figured. The same author (1914) has figured a pair of openings surrounded by the premaxillae in *Lycochampsa ferox*. These two forms are both Cynognathids, and the vacuity does not seem to have been recorded in any of the Therocephalia or Gorgonopsia.

Another interesting feature concerns itself with the vomer. In *Diademodon* there is a large median vomer lying between the pterygoids and palatines. Watson considers that in *Gorgonops* there is a large mammalian vomer in the posterior part of the palate as in *Diademodon* and a pair of fused prevomers anteriorly. In the Therocephalian *Scymnosaurus watsoni* (described by Watson as *Lycosuchus sp.*) there is a narrow vomer lying in the same position as in *Gorgonops*, and a pair of prevomers anteriorly. In *Scylacosaurus sclateri* there is no median vomer on the palate. From the general features of the skull under discussion one would expect to find in it some trace of a posterior vomer on the palate. I can, however, find no trace of sutures where such a bone is likely to occur, and, moreover, the pterygoids are seen to be separated from one another almost throughout their length by a median longitudinal suture. On the other hand, the bone separating the premaxilla from the pterygoids is a single bone, as in *Dicynodon*.

Such a bone in the Gorgonopsia is said by Watson to be a fused pair of prevomers and has been described by Broom as a true unpaired vomer. A section across the median bar just in front of the "transverse bar" shows the upper surface of this bone with a median ridge, bounded on each side by a broad shallowly concave depression and a lateral rounded ridge. Lying to one side of the median ridge is a narrow spike of bone which was doubtless a vertical median septum before crushing. It may be that in this skull we have a fused pair of prevomers and that the thin median bone seen above it in section which passes back to articulate with the pterygoids is the vomer. This latter may, however, be the mesethmoid.

Then the nature of the dentition is peculiar in that no molars are present. It might be supposed that all the teeth had been lost during life; but both skulls show the same features, and there are not even remnants of the alveoli still preserved, nor of roots when seen in section.

A portion of the lower jaw was found crushed on to the back of the type skull. It is part of the right dentary. Near the anterior end is a canine tooth, oval in cross-section. Just in front of this is seen in cross-section a much smaller tooth, occupying the position of an incisor. The outer surface of the anterior part of the dentary is rugose. The dentary is long and slender. Behind the canine the upper edge is regularly concave right back to the coronoid process, so that when the jaw is placed in position in the skull there is a wide gap between the upper and lower jaws behind the canines. Posteriorly the upper border of the dentary narrows. There is no distinct mentum, the dentary being thus more reminiscent of the Therocephalia or the Cynodontia than of the Gorgonopsia.

The lower jaw is more fully preserved in the co-type. The symphysis is long and loose. The front of the jaw is prow-shaped and there is no distinct mentum. Each dentary carries one large canine, and, fairly closely in front of it, one incisor.* The dentary is large and long, but not very deep, and has a very large coronoid process. The bone forms almost as large a portion of the lower jaw as in *Cynognathus*, and certainly a greater portion than in a Gorgonopsian such as *Scymnognathus*. The splenial is a small

* In a specimen consisting of the front halves of both dentaries from Kruger's Kraal, Graaff-Reinet, 3 incisors occur in front of the canine. This specimen probably belongs to the species under discussion.

bone playing little or no part in the symphysis. The post-dentary part of the jaw is seen partly in external view and partly as a cast of the inner side. The structure is somewhat difficult to determine as a certain amount of crushing has obliterated the sutures. There is a long posterior process lying ventrally as in *Cynognathus*—presumably part of the angular, which is much shallower anteriorly than in *Scymnognathus*. The prearticular and surangular are seen occupying their normal positions, but the actual articular surface is missing.

Although in the general character of its palate and occipital plate the form approximates to the Gorgonopsia, it differs from that group in the narrow parietal crest, the absence of the pre-parietal, and the absence of the vomer on the palate. It has been shown, too, that it differs also from the typical Therocephalia, Cynodontia, and Bauridae ; and I have therefore placed it in a new genus under the name *Whaitsia platyceps* named in honour of the Rev. J. H. Whaits, to whose zeal, energy, and knowledge as a collector South African palæontology owes such a debt of gratitude. This new genus may be considered as the type of a new family of Therapsida, the *Whaitsidae*.

Type.—Skull and partial lower jaw. S.A. Mus. Cat. No. 4006.
Co-type.—Skull and lower jaw. S.A. Mus. Cat. No. 4330.
Locality.—Zuurpoort, Graaff-Reinet District, C.P.
Horizon.—Lower Beaufort Beds, *Cistecephalus* zone.

Akidnognathus parvus n.g. et n. sp

The type skull of this species shows some interesting features. It was collected from the *Cistecephalus* zone of the Lower Beaufort Beds at Zuurpoort, Graaff-Reinet, C.P., by the Rev. J. H. Whaits. (S.A. Mus. Cat. No. 4021.)

The skull is small, the snout broader than high. Its greatest length is 107 mm., the greatest breadth 54 mm. The distance from the snout to the front of the orbit is 50 mm., the anterior-posterior diameter of the orbit 25 mm., and the interorbital width 22 mm.

The dental formula is doubtful ; it may be i5 c2 m7 or i6 c1 m7. The sixth tooth from the centre line is smaller than the other incisors, and it is not possible to determine absolutely whether it is carried by the premaxilla or the maxilla. In *Scaloposaurus* and *Ictidognathus* the number of canines is greater than one, and

there is thus no inherent improbability in supposing that this allied form has two canines. The 5 incisors, supposing the sixth tooth to be a canine, occupy a space of 22 mm. The second canine is the largest tooth, oval in cross-section, and having a longer diameter of 5 mm. There is a diastema between the 1st

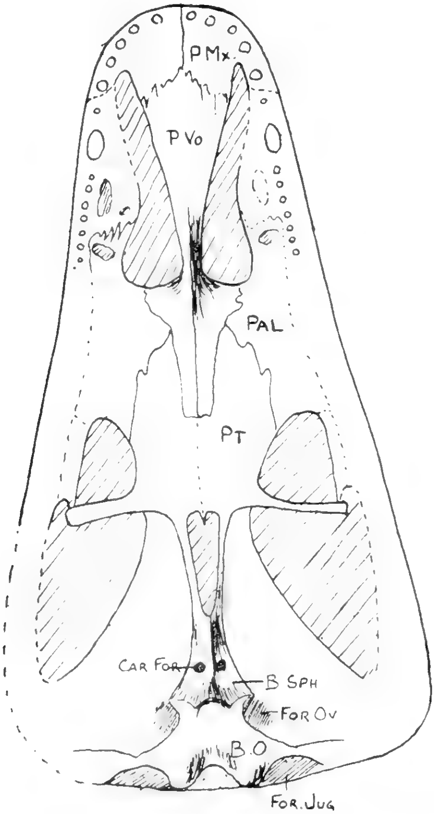


Fig. 51.—Palatal view of type skull of *Akidnognathus parvus.*

canine and the 5th incisor of 2 mm.; and one of equal size between the large canine and the 1st molar. The molars are much smaller than the incisors, and the 7 teeth occupy a space of 12 mm. The teeth are not serrated; the incisors are sharply pointed, backwardly curved, with longitudinal grooves. The molars are pointed, with anterior and posterior borders. Where the crowns are fully preserved, they are seen to be somewhat grooved.

The nostrils are large, close together, almost terminal, and look upwards and forwards.

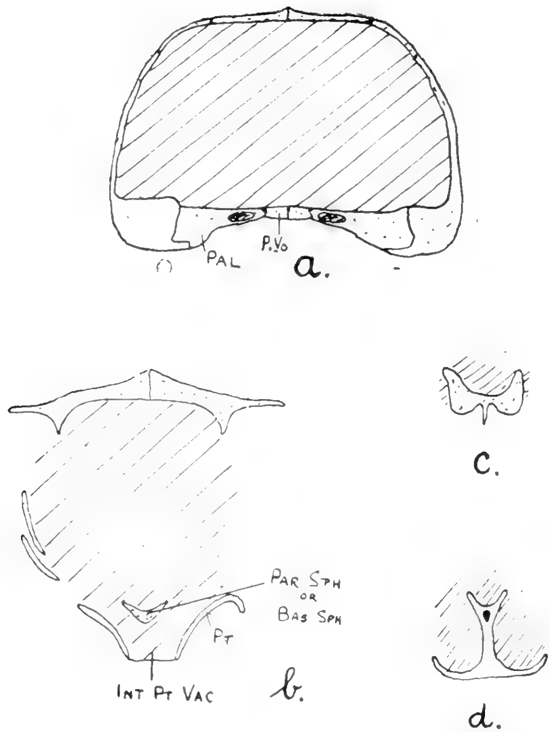
The bones of the skull surface are similar to those of *Scaloposaurus.* The frontal forms part of the orbital border. The parietal crest is ridged, but the parietal region is fairly broad ; the temporal openings are short. There is no postfrontal and no preparietal ; but a pineal foramen is present. The postorbital arch was possibly incomplete.

The basicranial region is essentially similar to that of *Scaloposaurus.* The occipital condyle is single. The large jugular foramen looks almost entirely downwards. The basisphenoidal tubera lying in front of the fenestrae ovales are stronger than in the specimen figured by Dr. Broom. The two carotid foramina lie one on either side of the posterior end of a short basisphenoid keel. Anterior to this the pterygoids are separated by a very long interpterygoid vacuity. The suborbital vacuity is present as in the Therocephalia and is bounded by the transpalatine, pterygoid, and palatine.

A fracture across the interpterygoid vacuity shows a small bone lying in the median line about 5 mm. above the level of the basisphenoid keel. In cross-section it is seen to have a roundly-keeled ventral surface and a shallowly concave broadened upper surface. This bone is not seen as a separate bone in a section taken a little further back, across the basisphenoid keel ; but the upper surface of the basisphenoid is similarly grooved. On the ventral surface of the latter bone there is a narrow groove on either side of the median keel.

Anterior to the interpterygoid vacuity the palate is slightly vaulted and rises slightly anteriorly. The structure seems to be similar to that of *Scylacosaurus* except that the distance between the posterior nares and the transverse process of the pterygoid is much shorter. The palatine occupies its usual position, forming part of the posterior border of the internal narial opening and of the anterior and inner borders of the suborbital vacuity, and articulating with the pterygoid and prevomer medially. Its inner portion has a longitudinal canal, covered both dorsally and ventrally with a very thin layer of bone. I cannot be certain of a median suture between the pterygoids. That between the prevomers is very definite in the posterior half of the bones, which reach very far back, but between them and the interpterygoid vacuity it is not definite. On the other hand, the presence of

a median vomer on the palate separated by sutures from the pterygoids is equally uncertain, and the structure of that region must remain doubtful. The bone is cracked in a rather symmetrical manner, which increases the difficulty of determining sutures.



AKIDNOGNATHUS PARVUS n.g. et n. sp.
FIG. 52a.—Section across skull just behind internal nares.
FIG. 52b.—Cross-section at middle of interpterygoid vacuity.
FIG. 52c.—Section across basisphenoid at front of keel.
FIG. 52d.—Section across prevomers near anterior end.

As mentioned, the prevomers are separated by a definite suture posteriorly; but anteriorly the suture becomes obliterated, and the bones broaden out and become thinner. A section across the front of the bone shows them forming a single median septum, thin below, but broadening dorsally to form a grooved upper surface. The palatal portion of the bone is thin and concave dorsally, as in *Ictidognathus parvidens.* In the upper part of the median septum there is a small canal.

There is an incipient secondary palate. The palatal surface of the maxilla has a groove terminating in a foramen which leads to a canal passing backwards through the bone. There is also an oval foramen in the palatine just behind its suture with the maxilla.

The lower jaw is slender and carries 4 or 5 incisors, 1 canine, and 6 molars. The dentary is long but not particularly powerful, and is not furnished with a distinct mentum. A section across the jaw at the level of the back of the orbit shows a splint of bone lying internal to, and separated from, the upper portion of the dentary. This splint is probably the coronoid. The hinder portion of the jaw is very reduced in depth and length. The angular and surangular can be seen, but their relations are not determinable.

The form is closely allied to *Scaloposaurus* and *Ictidognathus*, and may be safely placed in the Scaloposauridae. This family shows some affinities with the Bauridae, agreeing in the following characters :—

1. The short temporal region.
2. The nostril directed more forward than outward.
3. The frontal forming part of the orbital margin.
4. The small squamosal.
5. The interpterygoid vacuity.
6. The great distance between the posterior ramus of the pterygoid and the paroccipital process.
7. The suborbital vacuity.
8. The absence of the long narrow pterygoid-basisphenoid median bar.
9. The presence of a quadrate ramus of the pterygoid.
10. The feeble postorbital arch.

Features 3, 5, 7, and 9 are common also in the lower Therocephalia.

It differs from the Bauridae in :—

1. The nasal being slightly widened posteriorly.
2. The nature of the molar teeth.
3. The larger size of the interpterygoid vacuity, and the consequent great reduction of the basisphenoidal keel.

In the latter feature the Scaloposauridae differ more from the Therocephalia than do the Bauridae; but in the nature of the molars they approximate to the Therocephalia.

Type.—Skull and lower jaw (S.A. Mus. Cat. No. 4021).

Locality.—Zuurpoort, Graaff-Reinet District, C.P.

Horizon.—Lower Beaufort Beds (*Cistecephalus* zone).

CYNOSUCHUS WHAITSI, n.sp.

The form *Cynosuchus suppostus* was founded by Owen on the preorbital portion of a skull and lower jaw "from a claystone nodule in a (triassic ?) formation of the Sneeuwberg mountain range." He considered that it belonged with *Cynochampsa* to a "single-nostrilled group of Theriodontal Saurians." Both Owen's figures and description show the dental formula of the upper jaw in the type to be i4c1m8—there being 8 molars on the right hand side and 6 on the left.

Lydekker (1890) gave the number of upper molars as seven. He noted that the skull has been flattened from above, giving the muzzle an abnormal width. He also considered the absence of the internarial septum to be due to crushing.

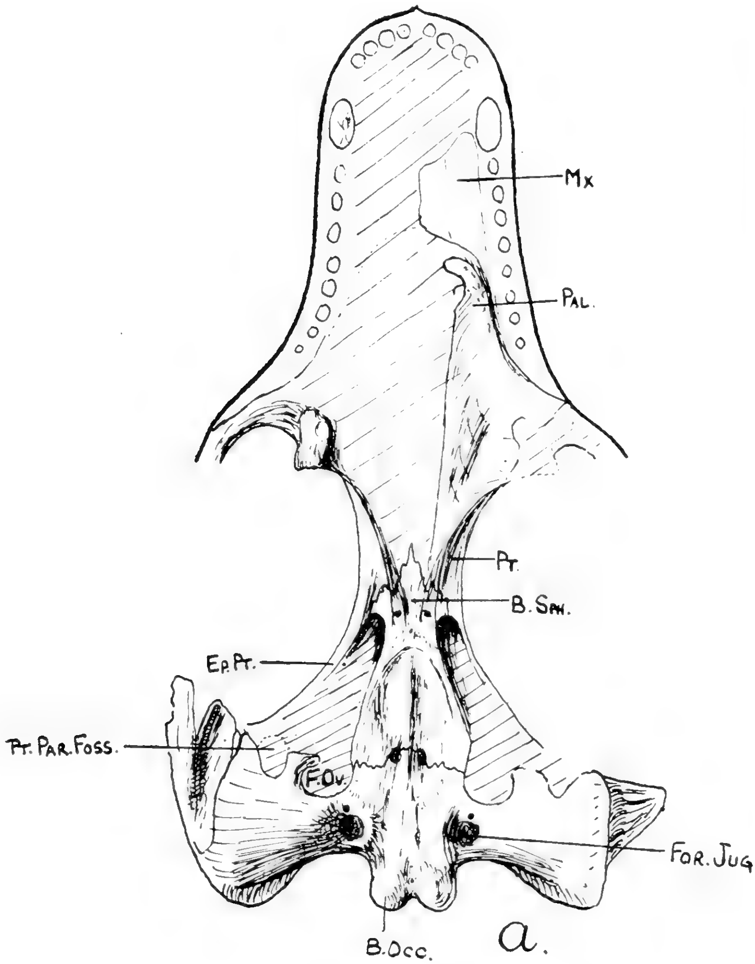
Broom in 1915 made the following remarks :—"*Cynosuchus suppostus* is known only by the imperfect type skull. It is a most remarkable form, having cusped molars and a secondary palate like the typical Cynodonts, but in other respects differing from all known Cynodonts and resembling more the Gorgonopsians. The dental formula is probably $i\frac{4}{4}c\frac{1}{1}m\frac{7}{7}$, and to whatever sub-order a more complete skull may show it to belong, it must be placed in a distinct family—the Cynosuchidae."

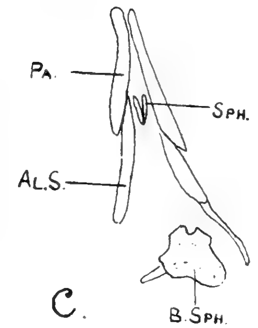
The discovery within the last few weeks of an almost complete skull by the Rev. J. H. Whaits enables some further observations to be made. Although, owing to the imperfect nature of the type, the type species is somewhat indeterminable, it seems probable that this new skull is closely allied to it, and should be considered as a member of the genus *Cynosuchus* known under the name *Cynosuchus whaitsi*. The skull was found at Weltevreden, in the Sneeuwberg range, Graaff-Reinet, at a height of 5,000 feet above sea-level, and is therefore from the top portion of the *Cistecephalus* zone of the Lower Beaufort Beds.

The skull is somewhat obliquely crushed, but the larger portion of it has been freed of matrix and the details of the structure beautifully displayed.

The greatest length was probably 125 mm., the antorbital length 50 mm., the interorbital width 27 mm., and the basal length 120 mm.

The dental formula is i4c1m8. The four incisors are closely set together and occupy a space of 14 mm. They are simple pointed conical teeth without serrations and curve slightly backwards. Each tooth has a few longitudinal grooves which do not





Cynosuchus whaitsi n. sp.

Fig. 53a.—Palatal view of type skull. x 1.
Fig. 53b.—Canine and molars of right side
Fig. 53c.—Section across skull at back of notch in alisphenoid

continue to the point of the crown. Behind the 4th incisor is a diastema of 5 mm. which is followed by the large canine tooth. This has a compressed oval cross-section with a longer—antero-posterior—diameter of 8.5 mm. It, too, is unserrated. Closely following the canine are the 8 molars (only 6 are preserved on the left side). These occcupy a space of 25 mm. Speaking generally, they decrease in size backwards; but they are not of equal age, the 2nd and 4th on the right side being probably immature, as they are smaller than their neighbours on either side. The 1st molar is to all intents and purposes a simple pointed tooth with a convex anterior edge and a concave posterior one. On the posterior edge there is a slight "step" but no true cusp. The 2nd has a slight protuberance on the posterior edge at about midway down, so that the crown might be said to be formed of a long pointed anterior cusp and a short blunt posterior cusp. On the 5th tooth the posterior cusp is much more pronounced, while the 6th and 7th seem to possess two posterior cusps. The last molar is a short simple tooth. A figure showing the details of the molar dentition is given.

The nostrils are somewhat higher than wide and are separated by a thin internasal septum formed by the premaxillae and the nasals. The floor of the nostril is formed by a small septomaxilla which appears only to a slight extent on the face. Between the septomaxilla and the maxilla is an external foramen, seen in many of the carnivorous Therapsida.

The top of the skull is very similar to that of *Diademodon.* The nasals are narrow anteriorly but broaden at their junction with the lachrymals, and narrow again slightly between the prefrontals. The prefrontal forms the anterior half of the supraorbital margin. Posteriorly it unites with the postorbital to shut out the frontal completely from the orbit. The frontal is a narrow bone broadest anteriorly, and sending forward a narrow anterior lateral process which separates for some distance the nasal from the prefrontal.

The maxilla occupies most of the cheek and is pierced by a number of small foramina. It passes back below the jugal to below the middle of the orbit.

The lachrymal forms most of the anterior border of the orbit. It is pierced just behind its suture with the maxilla by the lachrymal foramen which communicates by a short canal through the bone with a foramen within the orbit. Within the orbit there is also another smaller foramen above the one referred to.

The jugal is incomplete, but does not seem to have an inferior process.

The parietal region is narrow and crested. The pineal foramen is small.

The squamosal is crushed, but appears to approximate fairly closely to that of *Diademodon*. It has the groove on the posterior surface connected with the external auditory meatus, which does not, however, pass over on to the top of the skull. There is a process directed inwards separating the end of the paroccipital process from that of the pterygoid; this plate bears one deep notch below, instead of two as in *Diademodon*. The quadrate is not preserved.

The basicranial axis has been cleared on its ventral surface, and the side-walls of the brain-case are visible; and both bear a striking resemblance to the corresponding parts in *Diademodon*. Anterior to the pterygoid flanges the palate has not been wholly cleared, but posterior to them nearly all the details of structure can be seen.

The median ridge of the pterygoids is shorter than in *Diademodon*. Posteriorly it splits into two which form the lateral borders of the triangular area bounded behind by the occipital surface.

The occipital condyle is imperfect; but there is no doubt that it was double—the left half is wholly preserved—and formed by the basioccipital. At the side of it, facing laterally, is a small foramen for the exit of the XIIth nerve. The suture between the basioccipital and the basisphenoid is seen to pass across the basicranium between the two fenestrae ovales. Laterally the basioccipital articulates with the massive paroccipital process but the suture between the two is not visible. The front face of this process is excavated at its inner end to form the posterior border of the fenestra ovalis. Laterally to this the front face is pierced by the pterygo-paroccipital foramen, whose anterior border is formed by the posterior ramus of the "pterygoid."

Behind and medial to the fenestra ovalis is the foramen jugulare which is a deep pit looking entirely downwards. Piercing the anterior wall of this pit is a small foramen, corresponding to one of those seen in *Cynognathus*.

The under surface of the basisphenoid is slightly concave with a low median ridge and two lateral ridges which die out before reaching the fenestrae ovales. There are no distinct basisphenoidal tubera. On either side of the median ridge just behind the suture with the basioccipital are two small pits in the latter bone which

may lead into foramina. Anteriorly the basisphenoid narrows and sends a short process forward between the pterygoids. On each side is a short basi-pterygoid process which does not seem to have the long slender splint lying on the inner side of the posterior ramus of the pterygoid described by Watson in *Diademodon.* The upper surface of the basisphenoid has a median groove.

The side-wall of the brain-case does not differ in structure from that of *Diademodon.* The suture between the prootic and the epipterygoid (alisphenoid of Broom in *Cynognathus*) runs upwards from the middle of the foramen which gives exit to the 2nd and 3rd branches of the Vth nerve to the sinus canal. The anterior edge of the epipterygoid—the suture between it and the pterygoid is not easily seen—is notched deeply by the opening transmitting the II, III, IV, V and VI nerves. Superiorly it articulates with the parietal.

Fractures show cross-sections of the skull above the incisura prooticum and just behind the orbit. In the former section are seen two shallow plates of bone lying vertically between the parietals and close together. In the second these two plates have become much deeper, thinner, and somewhat further separated. These are presumably crushed sphenoids or orbito-sphenoids.

The front part of the palate has not been wholly cleaned; but there was certainly a nearly complete secondary palate, even if the maxilla did not wholly meet its neighbour in the middle line. The palatine is mainly a vertical bone. The ventral edge of the bone medial to its suture with the maxilla is rugose. The presence of a median vomer on the palate is not certain. The pterygoid flange is large and descends considerably below the level of the upper jaw.

As far as can be seen this form is extremely closely allied to *Diademodon.* The structure of the brain-case, the foramina for the exit of the nerves, the double condyle, and the general "look" of *Cynosuchus* all bring it close to *Diademodon,* from which it is separated stratigraphically by the whole thickness of the Middle Beaufort Beds. The most important differences are that in *Cynosuchus*

1. the foramen jugulare is more widely separated from the fenestra ovalis;
2. the basipterygoid process of the basisphenoid does not send out a long splint to lie along the inner side of the posterior ramus of the pterygoid;

3. the groove for the external auditory meatus does not continue on to the top of the skull ;
4. the squamosal has apparently but one deep groove for the reception of the quadrate ;
5. the molars are only cusped in a simple manner ; and
6. in the anterior portion of the basisphenoid just medial to the end of the large groove between the bone and the posterior ramus of the pterygoid there is on each side of the bone a small foramen which may be a Vidian foramen. This has been noted by Watson in a single Gorgonopsian skull, but is not present in *Diademodon*.

In all these features *Diademodon* can be considered a direct advance upon *Cynosuchus*. The brain-structure of the two closely approximates ; the nature of the dentition is not so close. The latter is probably a secondary advance, although there is not very much difference between the molars in *Cynosuchus* and in *Nythosaurus*.

Type.—Somewhat crushed skull (S.A. Mus. Cat. No. 4333).
Locality.—Weltevreden, Graaff-Reinet, C.P.
Horizon.—Lower Beaufort Beds—*Cistecephalus* zone (near top of).

Notes upon the Brain-case in certain Therapsida.

Dinocephalia.—Hitherto comparatively little has been known about the detailed structure of the brain-case of the Dinocephalia. Watson, in his paper on the Order, has given the fullest account of the region and, *inter alia*, says : " There is a relatively small brain-cavity. This is throughout higher than wide and has not been cleaned in any specimens ; fractures, however, show that it possessed the characteristic Therapsid character of having the large opening to the vestibule placed very low down in the skull. The floor of the brain-cavity rises considerably towards the front." Fortunately it has been found possible to obtain a sagittal section of the back part of a large Tapinocephaloid skull from the Gouph in the collection of the South African Museum, and to trace the position of the foramina opening into the brain-cavity. It has not been possible to work out, however, the structure of the inner ear on account of the intractability of the matrix. The following account contains incorporated in it the account published by Watson.

The most striking feature is the smallness of the brain-cavity compared with the immense thickness of the roofing-bones of the skull and of those of the occipital plate. The foramen magnum is small, oval in shape, higher than wide. In front of it the brain-cavity is not much enlarged, sloping gently upwards as an almost

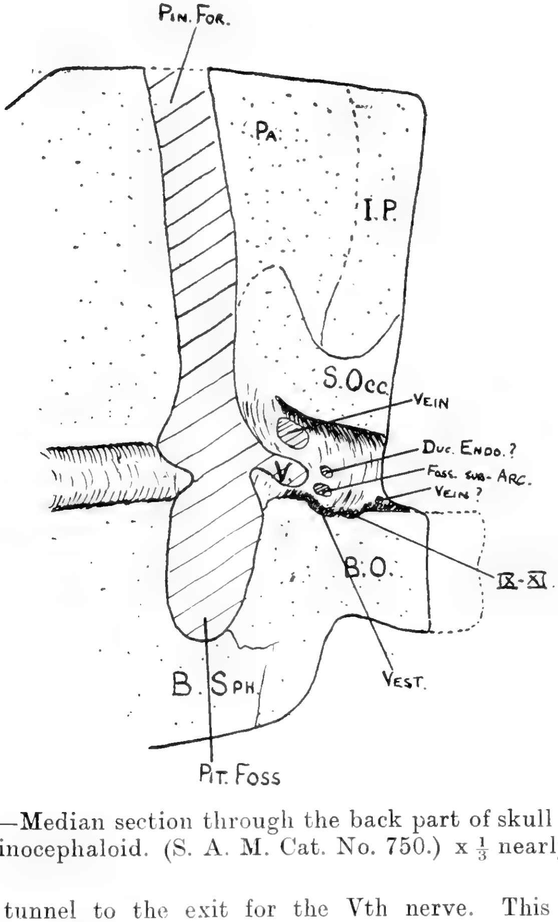


Fig. 54.—Median section through the back part of skull of a large Tapinocephaloid. (S. A. M. Cat. No. 750.) x $\frac{1}{3}$ nearly.

uniform tunnel to the exit for the Vth nerve. This cavity is throughout higher than wide. The posterior portion of the condyle is weathered away; but just anterior to the posterior face as preserved there is a small foramen in the side wall of the brain. This probably transmitted a vein. Anterior to it the floor of the brain-case is excavated on each side. The hollow thus formed is divided into two parts by a bony plate protruding from the lateral

wall and lying obliquely forwards in the hole. This divides the posterior foramen for the IX-XI nerves from the anterior opening into the vestibule. A short distance in front of this opening is a small oval foramen for the passage of the facial nerve. Above and slightly in advance of the vestibule there is a deep depression in the side-wall of the brain-case which is probably a floccular recess. Slightly behind that is a small foramen which may be the opening of the canal for the ductus endolymphaticus situated as figured by Watson in *Diademodon*.

The pro-otic forms the side wall of the case in advance of the vestibule. It is pierced above its anterior inferior process by two large foramina which are widely open laterally. The two are only separated by a thin flange of bone. The lower is for a branch of the Vth nerve, the upper possibly venous. In describing *Lamiasaurus*, Watson said: "The prootic, of course, contributes to the fenestra ovalis, above which it is perforated by the aquaeductus fallopii for the VIIth nerve."

The hypophysis is very deep and short, descending far below the level of the occipital condyle. Watson has figured the pituitary notch in external view in *Lamiasaurus* showing the rod-like epipterygoid partially covering it. The posterior wall of the pituitary fossa has a slight median ridge with a shallow pit on either side in the upper half. Laterally it curves round to form the posterior edge of the lateral opening, and has an anterior process above. The fossa, however, is not separated from the posterior part of the brain-case by any transverse wall. Above it the roof of the brain-case is pierced by a large hole which communicates with the pineal foramen by a very long, circular, slightly curved tube.

The bones of the brain-case have been described by Watson. In this form there is no deep vertical area below the basioccipital condyle—the structure approximates more to that of *Lamiasaurus* than to that of *Mormosaurus*. The fenestra ovalis does not lie very much below the level of the bottom of the condyle and sections show the stapes to be firmly fixed in it.

The paroccipital process is seen to be composed of a fairly thin plate of bone forming the posterior occipital face and a massive anterior portion which is probably the fused opisthotic and pro-otic. The suture between the basisphenoid and prootic is not visible.

The parasphenoid is a median plate of bone forming the front wall of the pituitary fossa. From the upper part of its posterior

border there is a process which projects into the fossa on a level with the floor of the posterior part of the brain-case. At the level of this process the side-face of the bone is provided with a broad shallow horizontal channel.

The epipterygoid is not visible, but Watson has described it as a slender rod rising very high in the skull with its posterior edge nearly in contact with the front of the prootic, arising from a small process of the pterygoid which curves round so as to shield the front of the fenestra ovalis.

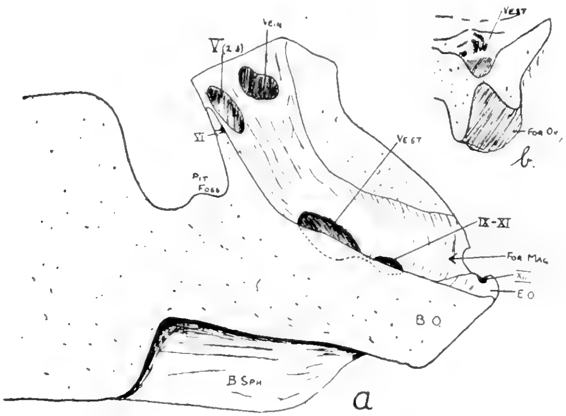
The occipital plate is weathered but the limits of some of the bones can be made out. There is a fairly small supra-occipital forming the upper border of the foramen magnum. The inter-parietal is a larger bone lying above the supra-occipital. The upper portion of its lateral edge articulates with part of the parietal which overlaps on to the side of the occipital plate; the lower portion with the tabulare. The post-temporal fossa is very small.

GORGONOPSIA.—In view of the generally accepted belief that the Gorgonopsia are nearly related to the Cynognathidae, and consequently close to the line of mammalian descent, it becomes important to elucidate as much of their detailed structure as possible. Watson, in a study of the external aspects of the brain-case, has traced a gradual change from *Dimetrodon* through *Arctops* and *Scymnognathus* to *Diademodon*, without, of course, suggesting that these genera lie actually on the one line of descent. It has recently been possible to study the interior of the brain-cases in one or two Gorgonopsia, and the results obtained are given here.

The first skull examined was a large skull—the largest Gorgon-opsian skull known to me—allied to *Scymnognathus tigriceps*. It was collected by the Rev. J. H. Whaits at a height of 3,500 feet on Zuurplaats in the Graaff-Reinet district, and is possibly thus from the bottom of the *Cistecephalus* zone. The interior of the brain-case has been completely cleared.

Watson in 1914 gave a short description of the brain-cavity of *Scymnognathus whaitsi?* accompanied by a figure of a sagittal section. The specimen showed "a distinct resemblance to *Diademodon* owing to the comparatively thin basioccipital and the large opening to the vestibule through the posterior end of which the tenth nerve has its exit. The general features of the vestibule recall *Diademodon*, but there is no visible trace of a cochlea. The chief differences from the more recent animal are

that the whole cavity for the cerebellum is much smaller, and that its base rises very rapidly in front, very much as it does in *Dimetrodon*. The pro-otic, although it extends further forward than in Anomodonts and *Dimetrodon*, has more of the greater anterior projection which, occurring in *Diademodon* and also in *Ornithorhynchus*, has a long suture with the parietal."



SCYMNOGNATHUS TIGRICEPS ?

FIG. 55a.—Diagrammatised sagittal section through back part of skull No. 4334.

FIG. 55b.—Section across vestibule of same. Both figures x $\frac{1}{2}$.

In the skull of *Scymnognathus* mentioned above (S.A. Mus. Cat. No. 4334) the occipital condyle is crushed, so that seen from behind it forms but a half-ring below the small foramen magnum. It is actually a large condyle with a central notochordal pit. The basioccipital is fairly thin. It seems to play little or no part in the border of the foramen magnum.

The paroccipital process has a concave lower border. It is higher in front than behind. Its upper surface forms the lower border of the small post-temporal fossa which lies on the level of the middle of the foramen magnum. The foramen jugulare is bounded above by the paroccipital and below by the exoccipital and looks almost entirely downwards. The front face of the paroccipital process is fairly flat and forms the posterior border of the fenestra ovalis, which lies at about the level of the notochordal

pit in the occipital condyle. The front face is lightly channelled horizontally by two small grooves, each ending in a foramen for a vein.

The inside of the brain-case has been wholly freed from matrix, and shows the positions of the foramina for the exit of the cranial nerves. In front of the foramen magnum the opening is narrow for a short distance, being bounded laterally by the exoccipitals. In front of these it broadens and its plane is horizontal for about 20 mm., when its base slopes abruptly upwards. The exit for the XIIth nerve is seen to pass through the exoccipital almost at the top of the condyle. Anterior to the exoccipitals the floor of the brain-case falls away laterally to the foramen jugulare, nerves IX-XI passing out through an ill-defined broad groove in the floor, which expands laterally. Anterior to this, the horizontal portion of the floor has a strongly marked rounded median ridge which separates the two inner ear-openings from one another. These lie fairly close together in pits excavated wholly in the floor of the brain-case. There is no abrupt line of demarcation between this opening and the proximal end of the course of the IX-XI nerves; and one may consider that there is one large excavation—shallow behind and deeper in front—the former passing to the foramen for the exit of nerves IX-XI and the anterior portion being the opening into the vestibule.

Anterior to the vestibule the floor of the case slopes upward forming a plate about 40 mm. long in the middle, longer at the sides, and thinner above than below. The front of this plate slopes backwards and downwards until it forms the base of the pituitary fossa, in front of which it rises again almost vertically. In a specimen which may be an immature skull of *Gorgonognathus* this plate is high and vertical behind the pituitary fossa and is divided by an open median vertical suture.

A fracture shows the inner ear to be connected with the fenestra ovalis by an hour-glass shaped passage about 25 mm. long. This passes mainly outwards and slightly downwards. The constriction in the middle is very pronounced and nearer the inner than the outer end. The fenestra ovalis is very wide, wider than the upper end of the vestibule. It is separated from the foramen jugulare by the process of the basioccipital which forms its anterior border. The fenestra ovalis is entirely surrounded by bone, thus differing from that of *Diademodon.* At the upper end of the ear the course of the semicircular canals cannot be distinguished. The foramen for the VIIth nerve has not been seen.

The foramen for the exit of the VIth nerve is seen considerably in advance of the vestibule, more than half-way up the sloping portion of the floor. It is a small foramen, but the course of the passage of the nerve has not been determined.

The notch at the top of the sloping portion of the floor is saddle-shaped. On either side of it the bone is prolonged forwards by two short processes—the processi anteriores inferiores of the prootics.

The side-wall of the posterior part of the brain-case is nearly vertical seen from within. Just above the vestibule it is somewhat excavate—possibly the depression is the fossa sub-arcuata. On the wall are two large oval foramina separated by a thin splint of bone. The anterior of these lies just behind the anterior wing of the sloping floor, and with its longer axis inclined. The side-wall of the case is here very thin, and the canal from the foramen is short, passing outwards and downwards. This foramen is probably the incisura prooticum for the exit of branches 2 and 3 of nerve V. Slightly posterior to and above the foramen is a more irregularly-shaped opening, which is probably the equivalent of the venous foramen figured by Watson in *Diademodon*.

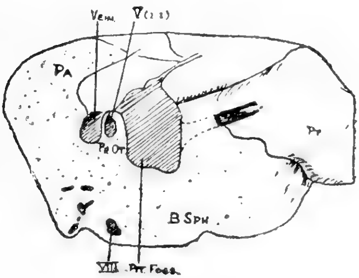
The basioccipital and basisphenoid are separated by an ill-defined suture occupying the position seen in a well-preserved skull of *Scylacops capensis*. The suture runs from the middle of the lower border of the fenestra ovalis slightly forwards to the median line of the deeply-vaulted region between the basisphenoid keel and the basioccipital condyle, and then back to the fenestra ovalis of the other side.

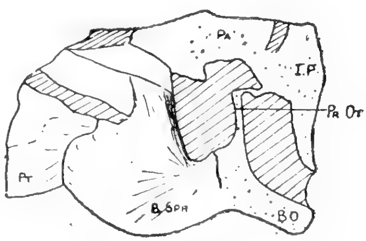
Posteriorly the under surface of the basisphenoid is deeply vaulted; the under surface suddenly bends vertically downwards and becomes a median keel passing forward to meet the pterygoids, between which the anterior portion seems to be clasped. The lateral ventral ridges are thick, but are not swollen into tuberosities. They form the anterior borders to the fenestrae ovales. Above the fenestra ovalis the suture between the pro-otic and the basi-sphenoid runs upwards and forwards to the lower posterior border of the pituitary fossa. The lower and anterior borders of this high, short opening are formed by the basisphenoid which continues forward as a vertical median sphenoid clasped by the vertical median plates of the pterygoids. Below the pituitary fossa and posterior to the suture between the pterygoid and the basisphenoid

is a small foramen leading into a canal which passes up through the body of the bone into the hypophysial fossa. This is possibly a carotid foramen.

The pro-otic forms the posterior and part of the ventral borders of the pituitary fossa. Superiorly it is pierced by the incisura pro-oticum and posteriorly it forms with the inner end of the opisthotic the border of the oval foramen lying between the post-temporal fossa and the incisura pro-oticum.

The epipterygoid is preserved on the left side of the specimen. Its ventral end is a broad thin plate and is supported by the posterior horizontal ramus of the pterygoid, from which it seems to be distinctly separated. Superiorly the bone soon becomes a small rod, oval in cross-section, and covering the incisura pro-oticum.





GORGONOGNATHUS LONGIFRONS Htn.

FIG. 56.—Back half of type skull sectioned vertically, seen from right and showing some of the foramina. x $\frac{1}{3}$ nearly.

FIG. 57.—Back half of type skull sectioned vertically near median line, seen from left. x $\frac{1}{3}$ nearly.

Gorgonognathus longifrons.—The type-skull of this species shows one or two further details. The back half of the skull has been split by a slightly oblique longitudinal vertical section through the middle of the occipital condyle, but it has been impossible—owing to the extreme hardness of the matrix—to clear the cavities.

The posterior part of the brain-case is of the same type as in the previous skull, but the process of the pro-otic forming its anterior boundary is rather more vertical and somewhat longer. Posterior to its upper end on the side-wall is seen the incisura pro-oticum and, separated from that by a thin splint of bone, is the large irregular foramen which has been considered venous. Superiorly the prootic meets the descending plate of the parietal; but just

in front of the meeting place of the two bones the parietal lies above a plate of bone which forms the upper border of the hypophysial fossa and passes down some distance on its front border to meet the basisphenoid. Anteriorly this bone—which occupies the position of the parasphenoid of the Dinocephalia, at least in its lower half—meets the pterygoids.

The vertical ascending plates of the pterygoids are separated from one another in two places. The first is seen in cross-section just above the palatal surface at the level of the lateral flanges. The other separation is the passage for the olfactory portion of the brain which passes upwards and forwards through the opening, doubtless swelling out anteriorly to form the olfactory lobes.

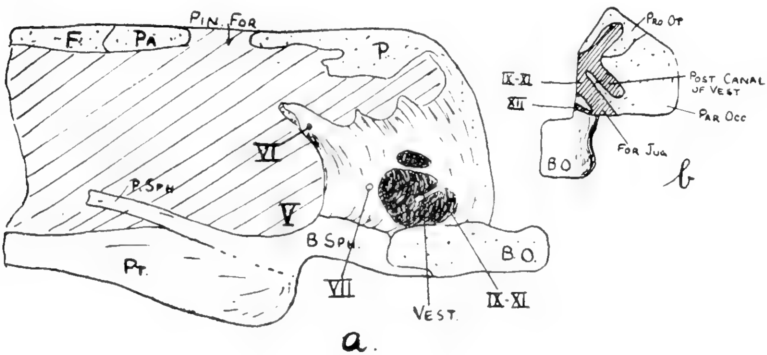
Scylacops capensis.—A skull of this species (Cat. No. 3444) from Wellwood, Graaff-Reinet, C.P., which was fractured longitudinally, has the bone so brecciated that the structure of the brain-case is indeterminable. It can be seen, however, that the posterior portion is somewhat longer and not so high as in the larger forms and the transverse pro-otic plate is not so vertical. The stapes is seen lying in position between the fenestra ovalis and the quadrate. The bone at its outer end is not rod-like, as it frequently seems to be when the under surface only is cleaned, but plate-like with a slightly convex anterior face and a parallel concave posterior face. The upper surface is expanded with a flat horizontal posterior projecting plate.

THEROCEPHALIA. *Alopecognathus minor.*—Although the matrix of the type of this species—which is from the upper part of the *Tapinocephalus* zone—is too resistant to allow of much development, the region of the brain-case has been broken through in several directions so that a certain amount of its structure has been made out.

In front of the foramen magnum the brain-case swells out laterally and vertically. The basioccipital forms most of the condyle. On the ventral surface of the skull it forms the anterior border of the fenestra ovalis and articulates with the basisphenoid in a jagged suture lying between the fenestrae ovales. In sagittal section, however, the basisphenoid is seen as a thin plate underlying the basioccipital which extends forwards above it to well in front of the level of the internal auditory meatus.

The posterior part of the basisphenoid is thin, forming a plate lying below the tubera basisphenoidales. Anteriorly it thickens and narrows until, at the pituitary fossa, it is a deep narrow plate which passes forward to be clasped ventrally between the pterygoids.

At its posterior end the basisphenoid forms, with the basioccipital, paroccipital, and prootic, a large rounded opening which is apparently not wholly enclosed by bone, being open on its outer side. The inner portion of this pit is the fenestra ovalis, which is partially walled in on the outer side by an anterior process from the paroccipital (opisthotic) which stretches forwards towards the suture between the basisphenoid and the prootic.



Alopecognathus minor Htn.

Fig. 58a.—Median longitudinal section showing wall of brain-case from within.

Fig. 58b.—Horizontal section across right side of brain-case just above the condyle.

The foramen jugulare lies on the back of the skull at the side of the occipital condyle. Its upper border is formed by the exoccipital, its lower by the basioccipital and the paroccipital. The inner opening for the IXth-XIth nerves lies low down on the side-wall of the brain-case, and the passage between it and the foramen jugulare passes backwards and slightly outwards and downwards. This canal is separated from the posterior canal of the vestibule by a forward and inwardly-directed thin wall formed from the inner end of the paroccipital process. Behind the inner foramen for the IX-XI nerves is a small foramen opening into a narrow canal which pierces the basioccipital and opens into the foramen jugulare.

It has not been possible to clean the inner ear, but the region is somewhat fractured and some of the details can be seen. The lower portion of the side-wall of the brain-case is perforated by a large hole, partly divided by the process of the paroccipital above-mentioned. Behind this wall of bone is the opening for the IX-XI nerves. Anterior to it the opening leads laterally into two elongate cavities separated from one another, as seen in cross-section, by a swelling of bone partly composed of prootic and partly of what seems to be an opisthotic part of the paroccipital. Ventrally the opening passes down, doubtless, to the fenestra ovalis.

Superior to the internal auditory meatus the wall of the brain-case is provided with a broad rounded ridge, above which is a fairly deep fossa subarcuata, bounded anteriorly and superiorly by the prootic. Just anterior to the lower border of the vestibule opening is a small canal passing downwards and slightly outwards—the aquaeductus fallopii for the VIIth nerve.

The upper part of the prootic is pierced laterally by one large foramen and possibly by another. The larger anterior one is for part of the Vth nerve; the possible posterior one venous. In front of the larger foramen the pro-otic is carried forward and upward as a processus anterior prootici. This, on one side of the skull, is pierced by the foramen for the VIth nerve. Superiorly the prootic articulates with the parietal.

The prootic forms the posterior border of the pituitary fossa; but it shows a striking difference from the bone in the Gorgonopsia in that it does not meet its neighbour in the middle line to form a high ascending transverse plate. The portion of the bone pierced by the VIth nerve is merely a lateral anterior process; between it and its neighbour the bone is deeply notched as in *Diademodon.*

In front of the pituitary fossa there is no vertical plate of the basisphenoid such as is seen in the Gorgonopsia I have examined, but the basisphenoid is continued forward as a shallow, thin, slightly upwardly inclined splint of bone whose outer side is broadly grooved. This median splint does not articulate with the vertical plates of the pterygoids, which are separated from each other to accommodate a median canal.

A medium-sized Therocephalian skull from Wilgebosch (Lammer Kraal), Prince Albert District, C.P., shows some additional features.

The specific identity is doubtful, as the dentition is not well displayed, but the form is from the middle or top of the lower half of the *Tapinocephalus* zone. The pro-otic has similar features to that of *Alopecognathus minor* except that the anterior processes are more vertical and longer.

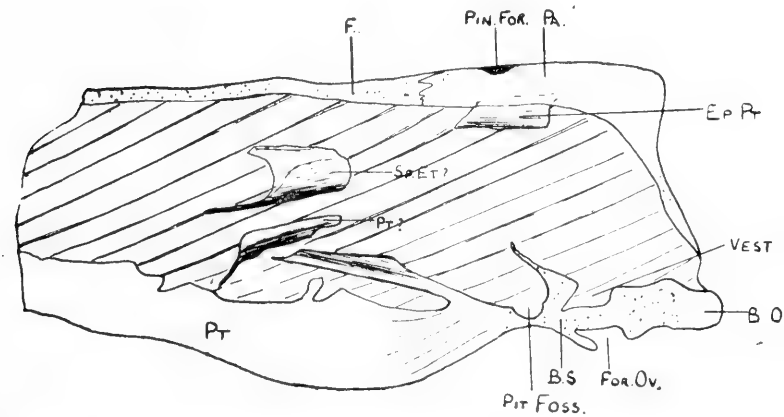


Fig. 59.—Irregular longitudinal section of Therocephalian No. 4332.

A fracture has shown the posterior ramus of the pterygoid, a thin arched plate of bone which posteriorly forms the outer border of the fossa which opens into the brain-cavity laterally through the pituitary fossa.

Articulating with the outer face of this plate and rising directly upwards from it is a fairly broad thin slightly curved lamina of bone which articulates above with the parietal. The posterior limit of this bone, which must be the epipterygoid, is not seen; but the plate appears to have extended sufficiently far back to have covered the pituitary completely from side view.

There is a fairly large elongate interpterygoid vacuity. A median section shows a thin median vertical plate of bone lying some distance above this—which plate may be an anterior prolongation of the basisphenoid or a parasphenoid. Above this is a median bone whose cross-section is an inverted V; and in contact with the dorsal ridged surface of this is a hollow cylinder of bone which may be open at the top below the roofing bones of the skull.

This is reminiscent of the sphenethmoid surrounding the anterior part of the brain in *Pareiasaurus* described by Watson. Unfortunately, the complete course of the bone is not seen; the bony walls of the cylinder are very thin. The anterior prolongation of the basisphenoid is sheathed by the inverted V-shaped bone, which may be formed of the ascending plates of the pterygoid.

General Considerations.—Taken in conjunction with the accounts already published of the brain-case in *Dimetrodon* and *Diademodon* and its allies, this study shows that in the essentials of structure there is a striking similarity throughout the whole of the carnivorous Therapsida. All have the inner ear lying well down in the brain—in many cases the vestibule pierces the floor—and not up in the side-wall, thus showing a mammalian affinity rather than one with modern reptiles. In this respect, the Dinocephalia seem to be quite as far advanced as forms like *Diademodon* from much higher zones.

It can be seen that the Gorgonopsia—at least as far as the larger types are concerned—do not approximate so closely to the Cynognathidae as a study of their external characters would indicate. In the first place the sloping, sometimes almost vertical, wall separating the posterior part of the brain from the hypophysis and pierced by the foramen for the VIth nerve finds no counterpart in *Diademodon* nor in the Therocephalia from the lower zones, where one simply finds the lateral portions remaining as processi inferiores anteriores prooticorum, separated by a deep notch whose base does not lie above the level of the bottom of the foramen magnum. In *Dimetrodon*, however. a similar transverse wall is seen, and in the Dinocephalia it may be present in some forms. Further, the epipterygoid in the Gorgonopsia as in the Dinocephalia is a rod-like bone with an expanded base; whereas in *Diademodon* and in at least some of the Therocephalia it is a plate.

Thus the Gorgonopsia seem to be more closely allied to the Pelycosauria and Dinocephalia than to any other sub-orders. This relationship has previously been noted by Broom and others from a study of the external characters; and it is important to find that evidence from the brain-case affirms their conclusions. It is unfortunate that no investigations have yet been made upon the Gorgonopsia such as *Galesuchus gracilis* from the lowest portion of the Beaufort Beds; but the palatal portion of a medium-sized *Scymnognathus ?* from the *Endothiodon* zone of Beaufort West accords well with the larger forms from higher up.

The discovery of the close relationship between *Diademodon* and *Cynosuchus whaitsi* from the *Cistecephalus* zone renders it probable that the line of descent of the Cynognathidae, if it passed through any of the Gorgonopsia at all, must have passed through some early form; the larger forms from the *Cistecephalus* and *Endothiodon* zones cannot be as close to that line as has hitherto been supposed.

The position of the Therocephalia is uncertain. The brain-case in the Bauridae and the Scaloposauridae is not known in detail; but it seems probable that some Therocephalian of the lower zones gave rise to the Scaloposauridae of the *Cistecephalus* zone and these in turn to the Bauridae of the Upper Beaufort Beds. Further, the Therocephalia studied seem to approximate to the Cynognathidae in the absence of the transverse wall behind the pituitary fossa and in the presence of a plate-like epipterygoid.

INDEX.

16.—*On Cretaceous Cephalopoda from Zululand.*—By L. F. Spath, M.Sc., F.G.S.

(With a Sketch Map, 4 Text-figures and Plates XIX to XXVI.)

Contents. PAGE.

I. INTRODUCTION.

The Cephalopoda that form the subject of the present paper were included in a collection of Cretaceous fossils, sent by the Director of the South African Museum, Cape Town, and the writer is greatly indebted to Mr. Henry Woods, F.R.S., for entrusting him with the study and description of these Cephalopoda. They comprise some eighty specimens, and their study has proved of the greatest interest. Aptian fossils are described from a new locality in South Africa, and, of the later forms, some are quite new to science, whereas others have not before been recorded from this continent. It may suffice to point out here that, *e. g.*, a near ally of "*Schloenbachia acutocarinata* (Shumard) var. *multifida*," Steinmann, *i. e.* of a group hitherto recorded chiefly from localities in North and South America, is represented in this collection. But the main interest of the collection lies in the demonstration of the occurrence, together, at some of the previously known fossil localities of Zululand, of deposits of varying dates, hitherto confused on account of similarity of matrix.

Some time ago, when re-examining Mr. Crick's types of Zululand Cephalopoda, in connection with the description of an Albian fauna from Angola,* it became clear to the writer that the collection from the South Branch of the Manuan Creek included Albian Ammonites. Mr. Crick† had considered that they "most probably represented a somewhat higher horizon (possibly Senonian) than that indicated by the False Bay fossils," which latter were regarded to be Cenomanian. Since Etheridge‡ already had described a *Douvilleiceras* and a *Lyelliceras* ?§ from the neighbouring Umsinene River, and since Mr. Crick‖ himself recorded, from the Middle Branch of the Manuan Creek, two undoubted Gault Ammonites, namely "*Hysteroceras*" [*Brancoceras*] sp. and "*Schloenbachia*" [*Dipoloceras*] sp., the presence of the Albian, at the South Branch also, was to be expected. In fact Mr. Crick identified four examples from this South Branch as ? *Beudanticeras beudanti*, *Anisoceras* sp., *Douvilleiceras* sp., and as "*Schloenbachia*" aff. *delaruei*, d'Orbigny sp.; the latter, a typical *Dipoloceras* of the *cristatum*-group (*s.l.*) was worked out of the matrix of one of the large *Cymatoceras* (referred to on p. 244) by Mr. Crick. But probably, on the one hand, Mr. Crick was doubtful about his identifications, for he did not mention these four important specimens in his paper; on the other hand, he may have been reluctant to assume different horizons for what appeared to be the fauna of one single formation. The Albian, Cenomanian and Senonian Ammonites may be preserved in a very similar brownish, friable matrix, and since there were as many Senonian as Albian forms (in addition to one Cenomanian *Acanthoceras*) present in the fauna from the South Branch, Mr. Crick described the whole as "possibly Senonian."

In a later paper, Mr. Crick¶ stated that the occurrence (in the Manuan Creek district) of Cretaceous beds of an age younger than Cenomanian was somewhat doubtful. On the other hand, Mr. R. B. Newton, in his paper on "The Cretaceous Gastropoda and Pelecypoda from Zululand,"** discusses the evidence in favour of a Senonian

* Read before the Royal Society of Edinburgh, December 6th, 1920. (See 'Nature,' vol. cvi, No. 2669, December 23, 1920, pp. 554–5.)

† "Cretaceous Fossils of Natal," pt. iii, No. 2: "The Cephalopoda from the Tributaries of the Manuan Creek, Zululand," 'Third Rep. Geol. Surv. Nat. and Zulul.,' 1907, p. 249.

‡ *Ibid.*, pt. ii, "The Umsinene River Deposit," p. 87.

§ *Gen. nov.* (type, *A. lyelli*, Desh. in Leym.; d'Orbigny, 'Pal. Franç. Ter. Crét.,' pl. lxxiv, figs. 1 and 2) dealt with in the writer's Angola paper.

‖ *Loc. cit.*, pp. 247–8.

¶ "Cretaceous Rocks of Natal and Zululand," 'Geol. Mag.,' N.S., dec. v, vol. iv (1907), p. 347.

** 'Trans. Roy. Soc. S. A.,' vol. i, pt. i (1909), pp. 94–5.

horizon for the Manuan Creek Fauna, and though he points out that "several of the species bear a distinctly older appearance," he goes on to say: "Taking into consideration . . . that there is no great difference in the lithological character of the matrix accompanying the various specimens from the Manuan Creek, it would seem that we are dealing with a fauna of one geological age which may be regarded as Emscherian or Lower Senonian, since it includes *Veniella forbesiana*, a characteristic pelecypod of the Upper Trichinopoly beds of Southern India . . ."

The Ammonites of the present collection include a number of typical forms that confirm the presence, at some of the localities, of deposits of various geological ages. The collection includes:

(*a*) A typical Albian fauna from "Manuan Creek" and the "Middle Branch, Manuan Creek" (19 specimens).

(*b*) Albian and Senonian Ammonitids from the "south side of Manuan Creek Valley," from "high ground on north side of United Manuan Creek and Umsinene River, almost opposite junction"; and from "Low Ridge about 3 m. east of foot of Lebombo Mountains, north of M'Kusi River, due east of Ubombo" (10 specimens).

(*c*) Senonian examples from the "North-West Shore of False Bay" (2 specimens).

(*d*) Aptian Ammonites from Powell's Camp, Upper Catembe (3 specimens).

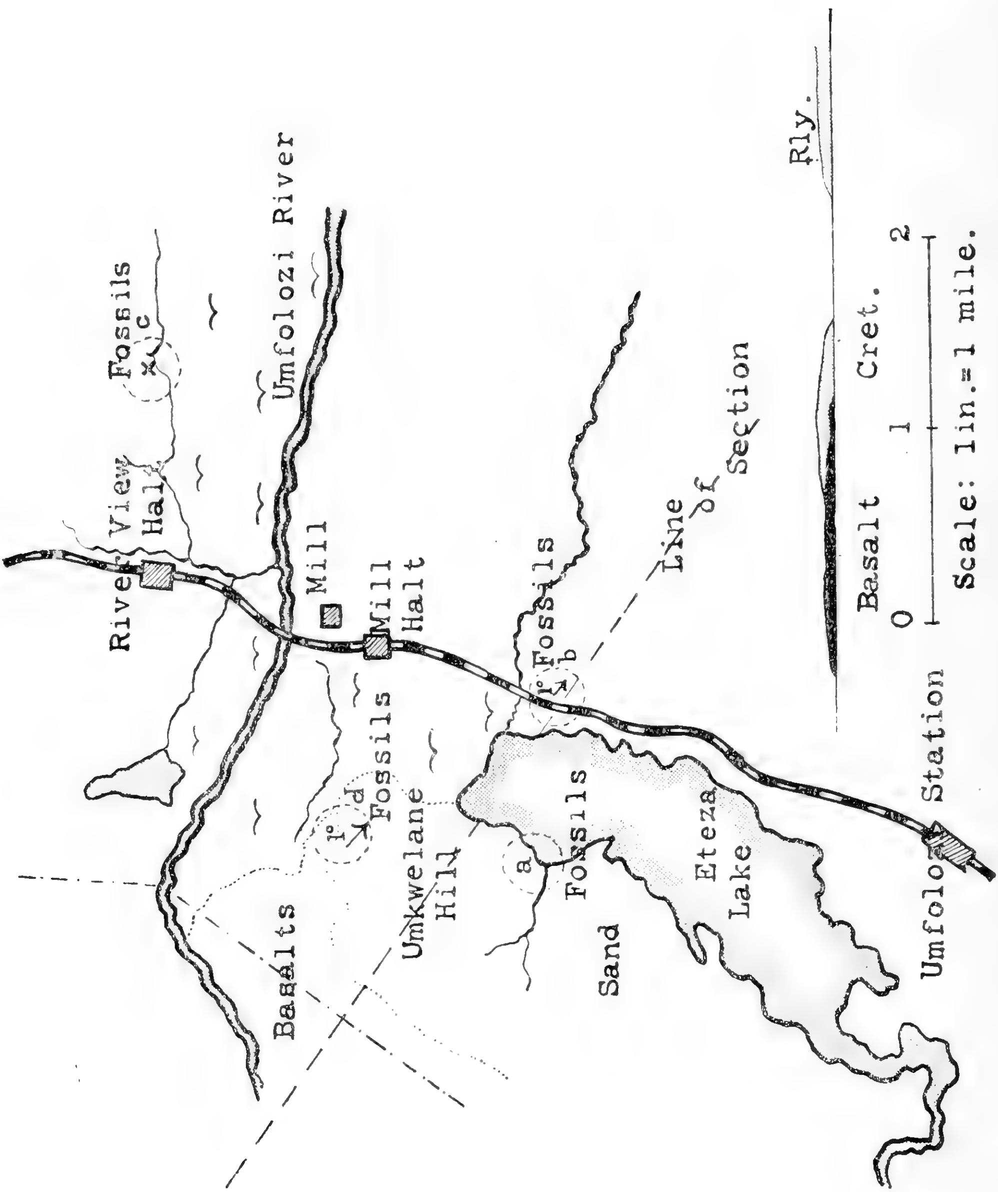
(*e*) A Senonian fauna from Umkwelane Hill. This includes over forty specimens (half of which number are *Baculites*), mainly from Umkwelane Hill itself (= *d* on the accompanying sketch-map), but comprising a few examples from the three neighbouring localities: Lake Itesa (Eteza) (= *a* on map), the railway cutting (= *b* on map), and the Umfolozi Valley, east of railway (= *c* on map). This fauna, first made known by Etheridge,* probably corresponds in age with the Pondoland fauna described by Woods.†

The following note by Dr. A. L. du Toit, dated March 20th, 1920, describes the nature of the deposits:

"At Umkwelane Hill, the Cretaceous rests directly upon Stormberg basalts (Liassic ?), the strata being hard shelly limestones and softer buff-coloured sandstones and other softer beds, rarely exposed; pebbles of older formations are found occasionally in them. The first fossiliferous limestone comes in a few feet from the base. These bands

* "Cretaceous Fossils of Natal," pt. i: "The Umkwelane Hill Deposit, Zululand," 'Second Report Geol. Surv. Nat. and Zulul.,' 1904, pp. 69–93, pls. i–iii.

† "The Cretaceous Fauna of Pondoland," 'Ann. S. Afr. Mus.,' vol. iv, pt. vii, No. 12 (1906).


River View Hall
Fossils
c
Umfolozi River
Mill
Mill Halt
Fossils
b
Line of Section
Fossils
d
Umkwelane Hill
Fossils
a
Sand
Eteza Lake
Basalts
Umfolo Station
Basalt
Cret.
Rly.
0
1
2
Scale: 1in.=1 mile.

are intensely hard and are crowded with lamellibranchs, etc., much broken shelly matter, but the fossils are difficult to extract.

"Along the railway cutting, the section shows dark-brown to khaki-coloured sandy stuff, without good bedding, with thin sandstone-ribs and concretionary limestone-nodules, in which Ammonites are found. Apparently, the same horizon is represented N. of the Umfolozi River at point **X** (see plan), where Ammonites are common. . . . The whole thickness of strata involved is probably not more than 250 feet, the dip being S.E. at 1° or $1\frac{1}{2}$°; and since the strata must have accumulated in shallow water, it is unlikely that several distinct zones are represented; all the fossils may therefore be considered to come from one horizon, and the beds and their fauna can therefore be regarded as a whole."

It will be advisable to describe the Umkwelane Hill fauna separately from that of the Manuan Creek and the other localities. There is a large collection of Ammonites from the Umzamba ("Umtamvuna") Beds of Pondoland in the British Museum, approximately corresponding in age with the Umkwelane Hill fauna, as stated by Woods * and by Crick † in his very useful general account of the "Cretaceous Rocks of Natal and Zululand." Crick was at work describing this fauna already before 1906 ‡ but his MS. is still unfinished, and the writer hopes to complete and revise it as soon as facilities for publication are offered. This collection in the British Museum includes a number of species not known to Baily, Griesbach, Woods and Van Hoepen, and not represented at Umkwelane Hill; and reference to some of these will be made in the specific descriptions when necessary. A new collection of Pondoland Ammonites, kindly sent to the writer by Mr. Henry Woods, includes a further series of undescribed forms. In his account of this fauna, to be published shortly in the 'Annals of the Durban Museum,' the writer is drawing attention to the improbability of such faunas representing only "one horizon." The great majority, if not all, of the Pondoland and Umkwelane Hill forms are of Campanian and Maestrichtian age, a possible range of at least five zones. The Pondoland strata are only twenty feet thick and of a sandy facies, suggesting rapid deposition; but the new collection contains doubtful or long-lived species that might even be pre-Campanian in age. The assertion, thus, is not justified that the corresponding beds at Umkwelane Hill, of a much greater thickness, can be regarded as belonging to "one horizon."

The third part of this paper will deal with the Manuan Creek

* *Loc. cit.*, p. 347.

† *Loc. cit.* ('Geol. Mag.'), p. 313.

‡ Woods, *loc. cit.* (1906), p. 337. Kossmat, "Die Bedeutung d. Südind.-Kreideform.," 'Jb. K.K. Geol. R.A.,' vol. xliv (1894), Heft 3 and 4 (1895), pp. 463–4

fauna; the few specimens from isolated localities, namely (*c*) and (*d*) above, are described separately under IV.

By the kindness of Dr. A. Smith-Woodward and Dr. F. A. Bather, of the British Museum, the writer has been able to make the fullest possible use, for comparison, of the rich collections under their charge. Similar facilities were accorded him by Prof. W. J. Sollas, Mr. C. J. Bayzand, and Mr. J. A. Douglas, at the Oxford University Museum; by Prof. A. M. Davies at the Imperial College of Science; by Dr. F. L. Kitchin at the Museum of Practical Geology. To all these gentlemen, and especially to Mr. Henry Woods, of the Sedgwick Museum, Cambridge, the writer expresses his cordial thanks.

II. THE UMKWELANE HILL FAUNA.

Description of Species.

A. AMMONOIDEA.

Family: DESMOCERATIDÆ:

Gen. PARAPUZOSIA, Nowak.

1. Parapuzosia sp. nov. ? ind.

(Pl. XIX, fig 2; Pl. XX, figs. 1, 1 *a*; Pl. XXIV, fig. 3.)

? 1906. *Desmoceras* (*Puzosia*) *gaudama* (Forbes) Boule, Lemoine & Thévenin, "Pal. de Madagascar," III, "Céphal. Crét. Diego-Suarez." Ann. de Pal., vol. i, fasc. iv, p. 20, pl. iv, fig. 5 only.

The writer has not seen the specimen upon which this description is based; but in addition to the measurements given below and to the two photographs here reproduced, a plaster cast of a portion of the inner whorls (Pl. XXIV, fig. 3) was forwarded, the specimen itself being too bulky to be sent. The measurements, according to Mr. S. H. Haughton's note, accompanying the photographs, are as follows:

Diameter . . .	670 mm.
Height of last whorl .	325 [= 48·5 per cent. of the diameter].
Thickness " " .	225 [= 33 " " "].
Umbilicus . . .	120 [= 18 " " "].

The specimen was also characterised as "looking very similar to one or other of the species of *Desmoceras* (*Puzosia*) described from Madagascar"; and since the inner whorls, according to the plaster cast of the dorsal impression, show the ribbing and compressed aspect of *P. gaudama*, Boule, Lemoine and Thévenin * *non* Forbes, the

* *Loc. cit.*, fig. 4 *a* of pl. iv, which, however, is more compressed.

specimen is compared with the gigantic Ammonite cited above, and by these authors doubtfully classed with Forbes' species, and with the smaller figured example. The suture-line seems to agree very well, judging from the photographs only; but the bulges on the inner portions of the lateral area, reminiscent at once of *Parapuzosia leptophylla* (Sharpe) and of certain *Pachydiscus* and *Parapachydiscus*, are not apparent in the photographs of the form here described. *P. gaudama* itself (B.M. Geol. Soc. Coll. 10487) is different, and *P. corbarica*, Grossouvre,* with a thickness of only 27 per cent. of the diameter, is too compressed. The ornament of the inner whorls of the example here described, however, is very similar to that of this species, as it also is to that of the more coarsely ribbed *P. daubréei*, Grossouvre sp.,† though, owing to the absence of the inner half of the lateral areas, the primary costæ are only just indicated, so that comparison with this species, the presumed genotype, is difficult. The sectional outline of Grossouvre's species given by Nowak ‡ is more compressed than that of the Zululand form. On the other hand Nowak's figure of the suture line § apparently shows good agreement, as does that of *P. leptophylla*, Sharpe sp.‖ The fine example of *P. daubréei* figured by Müller and Wollemann ¶ has a larger umbilicus and very strong primary costation.

Nowak is inclined to unite these two Santonian species, and considers *P. tannenbergica*, Fritsch and Schloenbach** to be closely related, but he also quotes, as an example of *Parapuzosia*, Stoliczka's *A. denisonianus*, which is pre-Senonian, like *P. austini*, Sharpe sp.,†† a form much nearer the ancestral *Puzosia*-type. *P. stobae* Nilsson,‡‡

* "Rech. s. l. Craie Sup.," II., Pal., "Les Amm. d. l. Craie Sup." 'Mem. Carte Géol. France,' 1893 (1894), p. 174, pl. xxvii, figs. 1 *a*, *b*.

† *Ibid.*, p. 154, pl. xxviii. ("*Sonneratia*," in Grossouvre.)

‡ "Unters. ü. d. Ceph. d. Ob. Kreide Pol.," iii, 'Bull. Ac. Sci. Cracovie ser. B (1913), pl. xliii, fig. 32, p. 363.

§ *Ibid.*, pl. xliv, fig. 40.

‖ 'Moll. Chalk England,' III, "Cephal." (1856), pl. xxi, fig. 2.

¶ "Moll. Fauna d. Unter-Senon v. Braunschweig," II, "Ceph.," 'Abh. Preuss. L.A.,' N.F., Heft 47 (1906), p. 8, pl. v.

** 'Cephal. d. Böhm. Kreideform.,' Prague, 1872, pl. ix.

†† *Loc. cit.*, II, 1854, p. 28, pl. xii, figs. 1 *a*, *b*.

‡‡ 'Petrif. Suec. form. cret.,' p. i, London, 1827, p. 5, pl. i. Moberg, 'Ceph. i Sverig. Kritsyst.,' II, "Artbeskrifn.," Sver. Geol. Unders., ser. C, No. 73, 1885, p. 18, pl. ii, figs. 1–5. Nilsson's figure is somewhat diagrammatic, but Moberg's example (1 *a*) represents a form apparently similar to the specimen here described, if more compressed. The suture-line, however, stamps *P. stobae* to be a *Parapachydiscus*, connected with such forms as *P. colligatus* by *P. exilis*, Binkhorst, which Schlüter (*loc. cit.*, p. 56) thought perhaps belonged to *P. stobae*.

which is a pachydiscoid development (*Parapachydiscus*) later than *P. denisoniana*, and which has *Puzosia*-like inner whorls, is also grouped here by Nowak. But the forms that continue the *Puzosia*-type into the Senonian (*P. gaudama*, Forbes, *P. indopacifica*, Kossmat, etc.), and once more produce transitional forms to *Kossmaticeras* (*P. darwini*, Philippi in Steinmann), cannot be classed in the same genus with *P. denisoniana* which developed a "*Pachydiscus*-stage" already in the Turonian.*

The inclusion of the Zululand example in this polyphyletic genus, then, is only provisional, and based on the assumption that *P. daubréei* is the genotype of *Parapuzosia*. The ornamentation of the inner whorls shows that it is not a *Parapachydiscus*; and the writer believes that it has nothing to do with the gigantic forms of the type of *P. seppenradensis*, Landois,† which Nowak,‡ in the writer's opinion wrongly, also considers possibly to belong to *Parapuzosia*.

Locality.—Railway cutting, Umfolozi. Coll. Dr. A. L. du Toit. S.A.M. Cat. No. 5513.

Gen. PARAPACHYDISCUS, Hyatt.

2. Parapachydiscus sp. nov. aff. colligatus, Binkhorst sp.§ (Pl. XXII, figs. 1 *a*, *b*.)

1861. *Ammonites colligatus*, Binkhorst. Mon. d. Gast. & Céph. de la Craie Sup. d. Limbourg, ii, p. 25, pl. viii *a* only.

1894. *Pachydiscus colligatus*, de Grossouvre. Amm. Craie Supér., p. 202.

1908. *Pachydiscus colligatus*, de Grossouvre. Descr. d. Amm. d. Crét. Sup. du Limbourg, etc. Mém. Mus. Roy. d'Hist. Nat. Belg., vol. iv (1908), p. 28, pls. iv–viii.

* Forbes ('Trans.,' 2nd ser., vol. vii, 1846, p. 114) stated that there was a "fragment of a very large Ammonite, but undeterminable, among the specimens from Trichinopoly." This example, now in the British Museum (Geol. Soc. Coll.), probably belonged to a form of this group of "*Puzosia*," but consists of one camera only (H. = 170 mm. and Th. just a little less). The extremely complex lateral lobe and short siphonal lobe are like those in *P. denisoniana*, as figured by Kossmat (*loc. cit.*, pl. xiv, fig. 6), but there is no ornamentation remaining at this pachydiscoid stage.

† "Die Riesen-Amm. v. Seppenrade," 23. Jahresb., 'Zool. Sect., Westfäl. Prov.-Ver. f. Wiss. and K.' (1895), pp. 99–108, pls. i and ii.

‡ *Loc. cit.* (1913), p. 365.

§ Kossmat (*loc. cit.*, p. 166 [101]) considered the two species, *colligatus* and *otacodensis*, to be closely allied, but the latter is quite different, judging by Kossmat's own identifications in the British Museum collections.

1913. *Pachydiscus colligatus*, Nowak. Unters. Cephal. ob. Kreide Polen, iii, Bull. Ac. Sci. Cracovie, ser. B, p. 361, pl. xliii, fig. 30, pl. xliv, fig. 39.

A completely septate specimen (No. 5489) of 145 mm. diameter has an umbilicus of about 20 per cent. of the diameter and a whorl thickness of about 60 per cent. The ribbing is obscure, the example being only an internal cast; but there are about 25 costae on the outer whorl, weakened at the grooved siphonal line and with a slight forward sinus. Some of these costae do not reach to the rounded umbilical border; those that do are not distinctly tuberculate, and the inner whorls, as shown in the deep umbilicus, are almost unornamented. There are only nine septa on the last whorl, but these attain an extreme degree of complication, equalled, perhaps, only by such forms of *Parapachydiscus* as *P. quiriquinae* (Philippi), Steinmann sp.

The specimen shows close resemblance with the examples figured by Binkhorst on pl. viii *a*, and which were selected as typical by Grossouvre, though Pervinquière * was of opinion that the large form figured by Binkhorst on pl. viii, and which was renamed *P. van den broecki*, should be taken as type of Binkhorst's species. †

The present example differs from the typical *P. colligatus* (pl. iv, fig. 3, and pl. v, fig. 1, in Grossouvre) only in having, at a radius of 75 mm., a thickness of 75 mm., not 52 mm. as given by Grossouvre: in other words it retains the globosity of the inner whorls of *P. colligatus* to a larger diameter. The costation, possibly, also is a little too distant in the Zululand example.

One of Schlüter's ‡ examples of *Parapachydiscus wittekindi* has this more distant costation and thick whorls, but judging by a number of Westphalian examples of this species in the British Museum, the wide and strongly costate umbilicus separates Schlüter's species from the form here described.

Parapachydiscus ? portlocki, Sharpe sp.,§ similarly differs from the latter in having a wider umbilicus, surrounded by tubercles. In whorl-shape, however (thickness = 60 per cent. of the diameter), the

* "Ét. de Pal. Tunis," I, "Céph. d. Ter. Sec.," 'Carte Géol. d. l. Tunisie' (1907), p. 175 (footnote).

† This "species" was withdrawn in 1908 by A. de Grossouvre, who then figured Binkhorst's original (in the Berlin Museum)—a poorly preserved example.

‡ 'Ceph. d. Ob. Deutsch. Kreide.,' I, Palaeontogr., vol. xxi (1872), *e. g.* example 2 of p. 68 (*A. robustus*), with thickness = 57 per cent. of the diameter, pl. xxi, figs. 5 and 6; pt. ii (1876), p. 160. Boule, Lemoine and Thévenin (*loc. cit.*, II, 1907, p. 22) wrongly consider this species of *Parapachydiscus* to be the type of *Pachydiscus*, Zittel.

§ "The Fossil . . . Mollusca . . . Chalk of England," II, 'Ceph.,' Pal. Soc. Mon., 1854, p. 30, pl. xiii, figs. 2, 3.

two forms are closely comparable, though the adult *portlocki* develops ventral tuberculation.

P. epiplectus, Redtenbacher,* included by Grossouvre and Nowak in the synonymy of *P. colligatus*, differs both from the latter and from the present example in the pronounced peripheral sinus in the costation.

P. quiriquinae (Philippi), Steinmann sp.† resembles the Zululand example in suture-line, and has a similar straight principal lobe, but is too thin and too closely costate.

"*A. newberryanus*," Meek sp., as figured by Gabb has a similar suture-line, but the costation is finer and closer, and the whorl-section is more compressed than in the specimen under description. On the other hand, Whiteaves § figures as *A. newberryanus*, Meek, an Ammonite which, judging by comparable examples from Vancouver Island in the British Museum,|| belongs to a group of forms quite different from the *Parapachydiscus* here discussed and related to the *isculensis*-group of Nowak and to *Kossmaticeras*. Of Japanese forms, *P. teshionensis*, Jimbo,¶ is less globose and less involute than the African example; it also has umbilical tubercles and a less complex suture-line. *P. naumanni*, Yokoyama,** resembles the specimen here described in globosity, but has varices with close costation, and a comparatively large umbilicus.

* "Ceph. Fauna d. Gosau-Sch.," 'Abh. K.K.R.A.,' vol. v (1873), p. 121, pl. xxviii, fig. 1.

† "Beitr. z. Geol. and Pal. S. Amer.," III, "D. Alt. und d. Fauna d. Quiriquina Sch. in Chile," N. Jb. f. Min., etc., Beil. Bd. x (1895), p. 74, pl. vi, fig. 3, Text-fig. 5 on p. 77.

‡ 'Pal. of Calif.,' vol. i (1864), p. 61, pl. xxvii, fig. 199, and pl. xxviii, fig. 199 *a*. Whiteaves ('Mesoz. Foss.,' p. 107), included this form in *A. complexus* var. *suciensis*, Meek; later (*ibid.*, p. 344) renamed *Pachydiscus suciensis*, Meek sp. (The reference is [wrongly] to *A. brewerianus*, Gabb, in both cases.) Three examples, doubtfully referred to *Pachydiscus complexus*, var. *suciensis*, by Kossmat, from Vancouver Island in the British Museum Collection, are quite different from the Californian Ammonite, which also is quite different from Meek's original *A. complexus* ?, var. *suciensis* ('U.S. Geol. and Geogr. Surv.,' Bull. No. II, 1876, p. 369, pl. v, fig. 2).

§ 'Mesoz. Foss.,' I, pt. ii. "Foss. Cret. Rocks Vancouver, etc.," 'Geol. Surv. Can.,' 1879, p. 109, pl. xiv, figs. 1 and 1 *a*.

|| Associated with *P. otacodensis*, Stoliczka (Whiteaves, *loc. cit.*, I, V, 1903, p. 340, pl. xlvi, fig. 1, and 'Trans. Roy. Soc. Can.,' 2nd ser., vol. i, sect. iv, 1895 [1896], p. 131), and other species of *Parapachydiscus* labelled by Kossmat (see 'Jb. K.K. Geol. R.A.,' vol. xliv [1894], p. 472).

¶ "Beitr. z. Kenntn. d. Fauna d. Kreidef. v. Hokkaido," 'Palæontol. Abh. Dames & Kayser,' vol. vi, pt. iii (1894), p. 30 (176), pl. iii, fig. 1.

** "Verstein. a. d. Japan Kreide," 'Palæontograph.,' vol. xxxvi (1890), p. 187, pl. xxii, fig. 1.

P. arrialoorensis, Stoliczka,* is very close to the Zululand example in shape, umbilicus and number of costae but differs in the character of the periphery, unless this difference, well seen on comparing fig. 1 *c* of Grossouvre's pl. v with fig. 3 *a* of Stoliczka's pl. lxiii, is due to the presence of the shell in the Indian form, which seems doubtful in view of its sandy matrix. However, the larger and somewhat different example figured by Yokoyama† shows distinct and sinuous costation on the ventral area both of the cast and of the shell. The suture-line of the Indian species also is simpler than that of the example here described.

P. colligatus has been recorded from Tullear, on the West Coast of Madagascar, and other species of "*Pachydiscus*," including *Jacobites* from other parts of the island.‡ Woods stated§ that *Pachydiscus* was absent in Pondoland; but there are four specimens from the Umtamvuna River in the British Museum,|| including two large examples that may belong to forms of the *colligatus*-group. The presence of "*Pachydiscus*" both in Pondoland and in Zululand thus forms a further point of resemblance with the Indo-Malgascan fauna.

Locality.—Umkwelane Hill. Coll. Dr. A. L. du Toit.

3. Parapachydiscus cf. wittekindi, Schlüter, sp.
(Pl. XXIV, fig. 1.)

1872. *Am. robustus*, Schlüter, "Ceph. d. Ob. Deutsch. Kreide," Palaeontogr., vol. xxi, p. 67, pl. xxi, figs. 5 and 6, pl. xxii, figs. 1–3.

1876. *Am. wittekindi*, Schlüter (*ibid.*), vol. xxiv, p. 40 (160).

* In Blanford and Stoliczka, "Foss. Ceph., Cret. Rocks of S. India," 'Mem. Geol. Surv., India, Pal. Indica' (1865), p. 126, pl. lxiii, fig. 3 only.

† *Loc. cit.* (1890), i, p. 186, pl. xxi.

‡ See Boule and Thévenin, 'Bull. Soc. Géol. France,' ser. iv, vol. iii, 1903, p. 436; Boule, Lemoine and Thévenin, *loc. cit.* (1907), pp. 23–25; Kilian and Reboul: "Les Céph. Néocrét. d. Îles Seymour et Snow-Hill," 'Wiss. Erg. Schwed. S. Pol. Exp. 1901–03,' III, 6 (1909), p. 25.

§ *Loc. cit.* (1906), p. 346.

|| Two of these, named *P. umtafunensis* by Crick (MS.), Nos. C19434–5, and compared with *P. tweenianus*, Stoliczka (*loc. cit.*, 1865, p. 107, pl. lv only), one of the species found in Madagascar, are evolute, like *P. conduciensis*, Choffat, and with comparatively simple suture-line, thus differing from the typical *Parapachydiscus*. They are similar to certain South-American "*Pachydiscus*" (Paulcke "Die Ceph. d. Ob. Kreide Südpatagoniens," 'Ber. Naturf. Ges. Freiburg i. B.,' vol. xv (1907), *e. g.* pl. xix [x]). The other two gigantic specimens, not described by Crick, may belong to *Parapachydiscus* of the *colligatus-supremus* type, but one has an umbilicus of 19 per cent. and a thickness of 45 per cent. of the diameter, the other at a whorl-height of 260 mm. a thickness of 200 mm.; both are more compressed than the Zululand specimens here described, and intermediate in sectional outline between figs. 30 (*P. colligatus*) and 31 (*P. oldhami*) in Nowak (*loc. cit.*, 1913, pl. xliii).

A gigantic example (No. 3969) resembles the form last described, but has a wider umbilicus. Its dimensions are:

Diameter	390 mm.
Height of the last whorl. .	46 per cent. of the diameter.
Thickness ,, ,, ,, . .	49 ,, ,, ,,
Umbilicus	25 ,, ,, ,,

The costation disappears on the ventral area and remains distinct on the inner half of the side, which is just the reverse of what takes place in *P. supremus*, Pethö sp.,* included in the synonymy of *P. colligatus*, Binkhorst sp., by Grossouvre and Nowak.† *P. fresvillensis*, Seunes,‡ and *P. epiplectus*, Redtenbacher,§ show a similar change, but one of the examples of the former species, figured by Seunes (pl. xii (iii), fig. 1), agrees with the specimen here described in having a somewhat reniform whorl-section, with the greatest thickness near the umbilical border. The latter character distinguishes the Zululand example from *P. teshionensis*, Jimbo,‖ which apparently weakens the ornament of the periphery and retains the principal lateral costae after the manner of *P. egertonianus* (Forbes), Stoliczka sp.,¶ which latter species, however, is far too compressed.

P. haradai, Jimbo,** and the larger example referred to the same species by Whiteaves,†† have more compressed whorls at a stage when the present form is still very depressed. It is also doubtful whether large examples of this species would develop the secondary ornamentation of the typical forms of this group. This equally applies to the evolute *P. steinmanni*, Paulcke,‡‡ that may or may not develop these obscure bulges at a large diameter, but resembles the form here described in the roundness of the inner whorls.

Schlüter's *A. wittekindi* differs from the form here described in whorl-section, though the inner whorls of the South African form apparently are more depressed than is its outer whorl. The Westphalian form also appears to lose its first costation at an earlier stage,

* "Kreidefauna d. Peterwardeiner Geb.," 'Palaeontogr.,' vol. lii (1906), p. 88, pl. v, fig. 1.

† *Loc. cit.* (1908), p. 29 and (1913) p. 361.

‡ "Contrib. à l'Ét. d. Céphal. Crét. Sup. France," 'Mem. Soc. Géol. Fr.,' Pal., vol. ii, fasc. iii (1891), p. 3, pl. i, fig. 1.

§ *Loc. cit.*, p. 121, pl. xxviii, fig. 1.

‖ *Loc. cit.* (1894), p. 30 (176), pl. iii, fig. 1.

¶ *Loc. cit.* (1865), p. 104, pl. liii, fig. 1.

** *Loc. cit.* (1894), p. 29, pl. ii, fig. 2.

†† "Vancouver Cret. Foss.," 'Trans. Roy. Soc. Can.,' 2nd ser., vol. i (1895), sect. iv, 1896, p. 132, pl. iii, fig. 6.

‡‡ *Loc. cit.* (1907), p. 230 (64), pl. xviii (ix), fig. 1.

and the costae of the secondary ornament (if the large and thin examples belong to the same species) are too pronounced on the venter. *P. seppenradensis*, Landois,* which was compared with *P. wittekindi* (and *Pachydiscus lewisiensis*) by Zittel, retains its costation to a very large diameter, but apparently belongs to the true *Pachydiscus* of the *peramplus* group, with comparatively simple suture-line.

P. levyi, Grossouvre sp.,† probably is a close ally of the Zululand form, but has pronounced umbilical tubercles instead of mere swellings of the primary ribs, as indicated in Schlüter's fig. 5 of pl. xxi.

The large forms of *Parapachydiscus* from Pondoland, referred to under *P. sp. nov. cf. colligatus*, are more compressed than the present example.

The suture-line of *P. wittekindi* is less complex than that of the Zululand form, which resembles in this respect the suture-line of *P. quiriquinae* (Philippi), Steinmann sp.,‡ especially in the straight line formed by the main stem of the principal lobe. The distance of this line from the parallel siphonal line is 95 mm. There is a slight groove on the periphery, marking the position of the siphuncle, as in *P. colligatus*.

The comparison of this species with *P. wittekindi* cannot be taken to indicate affinity with the European fauna, for they certainly are not specifically identical, and the present form is attached to Schlüter's species only because of Indo-Pacific species, that may be more nearly related, corresponding large stages are unknown, so that comparison is difficult.

Locality.—Umfolozi River, East of Railway. Coll. Mr. Illingworth.

4. Parapachydiscus, sp. ind.

Portions of a gigantic specimen (4985), at least half as large again as the example last described, and therefore probably of a diameter of about 600 mm., differ slightly from this other large specimen (No. 3969) in the suture-line. Only the peripheral portions of two camerae, including the greater part of the external saddles, are preserved; the median saddle in the ventral lobe alone is 46 mm. wide. The details of the ventral lobe differ somewhat from those shown in the peripheral aspect of *P. colligatus*, Binkhorst in Grossouvre§ (with which the small example (No. 5489) shows good agreement).

* "Die Riesen-Amm. v. Seppenrade," 23. Jahresb., 'Westfäl. Prov.-Ver. f. Wiss. and Kunst.,' 1895, p. 104, pls. i and ii.

† *Loc. cit.* (1894), p. 178, pl. xxi.

‡ *Loc. cit.* (1895), text-fig. 5, p. 77.

§ *Loc. cit.* (1908), pl. vi, fig. 1*a*.

The shell is partly preserved and 3 mm. thick in places, but less than 2 mm. in others. It is in two thick layers, fibrous and of a white porcellanous aspect, like certain *Inoceramus* shells in the chalk, with a thin inner and outer coating. The specimen may belong to a fat form of *Parapachydiscus*, like the two examples previously described, but is too incomplete for specific determination. The large *Parapachydiscus* from Pondoland are far more compressed.

Locality.—Lake Itesa (Eteza), Umfolozi. Coll. W. J. Wybergh.

Family: PRIONOTROPIDÆ.

Gen. MORTONICERAS, Meek.

5. Mortoniceras woodsi, sp. nov.

(Pl. XXI, figs. 1 *a–d*.)

The single specimen (No. 5451) upon which this species is based has the following dimensions:

Diameter	80 mm.
Height of the last whorl . .	45 per cent. of the diameter.
Thickness ,, ,, . .	40 ,, ,, ,,
Umbilicus	? 25 ,, ,, ,,

The important characteristics of this new species are (1) the decline of lateral and peripheral ornament on the last whorl, which is still septate, so that the specimen represents the inner whorls of an Ammonite that appears to lose altogether the typical *Mortoniceras* features; (2) the projection of the tubercle at the overhanging umbilical edge in an inward, not a lateral direction; (3) a comparatively small umbilicus.

Among a large number of *Mortoniceras* of the type of *M. soutoni* (Baily)* from the Umtamvuna River, in the British Museum, there are some transitional forms to the present species, showing decline of tuberculation on the outer whorl (at a considerably larger diameter) and a decrease in the size of the umbilicus. On the other hand, one of the forms figured by Stuart Weller† as *Mortoniceras delawarense*,

* The example figured by Woods (*loc. cit.*, 1906, p. 337, pl. xliii, fig. 1) represents a more evolute shell. Baily's type in the British Museum (Geol. Soc. Colln. No. 11365) has the decline of tuberculation more pronounced, but at a diameter of close on half a metre is still costate. Its small umbilicus brings it closer to the new species here described than is Woods' more evolute example.

† "Report on Cret. Pal. of New Jersey," vol. iv (Pal. Ser.), 'Geol. Surv. of New Jersey,' 1907, p. 837, pl. civ, figs. 1–3 only. (See under *Mortoniceras Vanuxemi*, Morton sp., p. 308.)

Morton sp., is considerably closer to the present species, as is one of the specimens figured by Whitfield,* which latter example, however, is of a considerably larger size. These forms of the *delawarense*-group, however, neither have the overhanging umbilical edge, nor the close costation of the present species, though they are nearer to the latter than is any other of the very numerous species of *Mortoniceras* described.

Pervinquière† doubtfully recorded *M. delawarense* (with varieties) from Tunis, but his specimens are much more strongly tuberculate than the new form here described and thus resemble *M. campaniense*, Grossouvre, which species subsequently was united by its author with *M. delawarense*.

One characteristic feature of these forms of the *delawarense* group is the weakening of the wide and low keel, carried to extremes in the fragment figured as *M. delawarense* by Julia A. Gardner.‡ It is difficult, from an inspection of the figure, to form an opinion as to the exact relationship of this form, for it has an almost flat, *Hoplites*-like ventral area. At any rate, its convergence towards such a form as the Upper Campanian *A. marroti* (Coquand), Grossouvre,§ is striking.

None of the species of *Mortoniceras* from the European Senonian resemble the form here described. The suture-lines of Grossouvre's Coniacian species are considerably simpler than are those of the Campanian *delawarense*-group. It has been possible to develop the internal portion of the suture-line of the present species, and a comparison with that of *M. texanum* (Römer) as figured by Schlüter|| is interesting as showing not only great increase in complication, but accommodation to a different whorl-shape. The suture-line of an

* "Gast. and Ceph. of the Raritan Clays, etc.," 'Mon. U.S. Geol. Surv.,' vol. xviii (1892), p. 252, pl. xliii, figs. 1, 2 only.

† "Études de Pal. Tunis," I, 'Céph. d. Ter. Second,' 1907, p. 243, pl. xi, figs. 21 and 22. Pervinquière, in his note (1) on p. 244, somewhat misrepresents Whitfield, for the remark in the latter author's description of *M. vanuxemi* (p. 254) refers to the compressed specimen he figures (pl. xlii, figs. 3 and 4), not to Morton's type. The latter is somewhat doubtful. It would be advisable to take as type of *M. delawarense*, Morton sp., figs. 6 and 7 in Whitfield, and as type of *M. vanuxemi* (Morton em. Whitfield), figs. 3 and 4 of the same plate (xlii) in Whitfield. Stuart Weller (*loc. cit.*, p. 839) unites the two species again—in the writer's opinion unjustly.

‡ "Up. Cret. Dep. of Maryland," 'Maryland Geol. Surv. Baltimore,' 1916, p 391, pl. xii, fig. 7.

§ *Hoplites vari*, Schlüter var. *marroti* in Grossouvre, *loc. cit.* (1894), p. 119, pl. viii, fig. 3 *b* = *Hoplitoplacenticeras*, Paulcke.

|| "Cephal. d. Ob. Deutsch. Kreide," 'Palæontogr.,' vol. xxi, part 2 (1872), p. 41, pl. xii, fig. 3.

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example of *M. soutoni* (Baily), very close to Baily's type, with small umbilicus, but comparatively smooth outer whorl (B.M. No. C19441, after G. C. Crick), also is given for comparison (Plate XX, fig. 4), since it differs considerably from that figured by Woods and from the original (faulty) drawing in Baily.

Locality.—Umkwelane Hill, Umfolozi. Coll. Dr. A. L. du Toit.

6. Mortoniceras aff. umkwelanense, G. C. Crick.

(Text-fig. D 2, p. 297.)

1907. *M. umkwelanense*, G. C. Crick, *loc. cit.* (Third Report), p. 228, pl. xv, figs. 9, 9 *a*.

Crick briefly characterised this species, which he considered to be related to *M. soutoni* and *M. stangeri*, as having a "subquadrate transverse section, a little wider than high." The example to be described (No. 5491) differs from the holotype (B.M. No. C18134) in several respects, but in view of the great variability of the nearly related *M. soutoni*, of which a large number is available, it is considered inadvisable to separate the present example from the specimen figured by Crick. The dimensions of the specimen in the present collection are:

Diameter	250 mm.
Whorl height	82 ,,
Whorl thickness	69 ,,

At a diameter of 160 mm. the measurements for height and thickness are 60 mm. and 62 mm. respectively; at 90 mm. diameter they are 33 mm. and 39 mm. Whereas, thus, the inner whorls are wider than high, and at a diameter of 160 mm. the whorl-height almost equals the thickness, as in the holotype, on the outer whorl the proportions are reversed and the whorl is higher than wide. It may be added that at 250 mm. diameter the specimen is still septate. Owing to the presence of an additional, if slight, tubercle on the lateral area of the specimen here described, the whorl-section is more rounded than that of the holotype, a feature still further accentuated by the removal, away from the umbilicus and higher up on the side, of the umbilical tubercle.

At a diameter of 90 mm. there are only fifteen coarse costae per whorl, as in the holotype. The suture-line is of the same general type as that of *M. soutoni*; the position of the umbilical tubercle, however, in the latter, corresponds with the second lateral saddle, whereas in the present example it coincides with the inner branch of the bifid first lateral saddle (compare Text-fig. D 2 with fig. 4 of Plate XX).

The presence of a fifth tubercle, smaller than the others, as it also is

in examples of *M. texanum* (Römer), makes the Ammonite here discussed somewhat of a transition between the compressed form next described and compared with *M. soutoni*, and Crick's holotype. The inner whorls, however, are different in the two developments, and there are other distinctions, as pointed out in the description below. In *M. soutoni*, as well as in *M. texanum* (Römer) and *M. quinquenodosum* (Redtenbacher), the umbilical tubercle is near the edge, and *M. campaniense*, de Grossouvre,* though the young has a similar squarish section and low keel, differs in its dichotomous costation.

It may be added that in the holotype of *M. umkwelanense* the keel has quite disappeared near the end—a feature of great significance, but not sufficiently apparent from the original figure. In the present example the two outermost tubercles are not quite so close, the keel between them not quite so feeble and not quite lost at the end.

Locality.—Umkwelane Hill. Coll. Dr. A. L. du Toit.

7. Mortoniceras sp. aff. soutoni, Baily sp.

A large but somewhat fragmentary example (No. 5492), of 180 mm. diameter, agrees with the evolute specimen figured by Woods,† and has fairly smooth inner whorls, with the lateral tuberculation only just indicated. The ribs also are, then, quite indistinct. The five tubercles become as conspicuous as they are in Woods' example and in Redtenbacher's *M. quinquenodosum*,‡ only just before the beginning of the body-chamber (at a diameter of about 100 mm.). The body-chamber, however, develops increasingly strong tubercles, which character separates the example here described from the typical and more involute *M. soutoni*; for Baily's type shows decline of tuberculation at a stage when the present example develops its strong tuberculation, and in the specimen of *M. soutoni* mentioned under *M. woodsi* (see *supra*, p. 234) the outer whorl becomes almost smooth. There are twenty-seven costae, as in the specimen figured by Woods; near the end of the specimen the whorl-height is 64 mm. as compared with a thickness of 55 mm. The whorl-section, thus, is considerably thicker than that of *M. texanum*, Römer,§ which, however, it greatly resembles in the spacing of the tuberculation.

The writer agrees with Woods|| in considering *M. bontanti*, de

* *Loc. cit.* (1894), pl. xiii, figs. 1 and 3.

† *Loc. cit.* (1906), p. 337, pl. xliii, fig. 1 *a*.

‡ "Cephal. Fauna d. Gosau-Sch. i. d. N.Ö. Alpen.," 'Abh. K.K.R.A.,' vol. v (No. 5), 1873, p. 108, pl. xxiv, fig. 3.

§ 'Die Kreidebild. v. Texas, etc.,' Bonn, 1852, p. 31, pl. iii, fig. 1 *b* (and 1 *e*?).

|| *Loc. cit.*, p. 338.

Grossouvre, to be quite different from Baily's species. On the other hand, the specimen figured as *M. texanum* by de Grossouvre* agrees with the example here described, both in the character of the ornament and in whorl-section, though the inner whorls appear to be quite different in so far as the fragmentary condition of the present example permits of comparison. De Grossouvre's example may be identical with Hauer's *A. texanus*† = *A. quinquenodosus*, Redtenbacher,‡ as Lasswitz§ thinks, if the thinness of the latter species is due to crushing, but the writer cannot admit the same author's identification with *M. texanum* of de Grossouvre's *M. campaniense*, a form near to *M. delawarense*, with which, indeed, de Grossouvre|| subsequently united it.

M. umkwelanense, Crick,¶ has much thicker whorls, with a square section, but the specimen here compared with Crick's species,** owing to the presence of a slight fifth (lateral) tubercle, is, perhaps, closer to the example under examination than is the type. In both, however, the umbilical tubercle is further away from the umbilical edge than it is in *M.* sp. aff. *soutoni*, and whereas in *M. umkwelanense* and in the close ally, described in this paper, the inner whorls are relatively more coarsely ornamented than the outer, the reverse development is found in the example here compared with *M. soutoni*.

It may be added that the great variability of the species here dealt with is shown in a large series of *Mortoniceras* from Pondoland in the British Museum, referred by Crick to Baily's two species and to an "intermediate" group.

Locality.—Umkwelane Hill. Coll. Dr. A. L. du Toit.

Gen. PSEUDOSCHLOENBACHIA, nov.

Genotype: *A. umbulazi*, Baily, 1855, pl. xi, fig. 4.

A. umbulazi, Baily, described as *Schloenbachia* by Woods†† and Crick,‡‡ has been considered by Kossmat §§ to belong to the "narrowly-

* *Loc. cit.* (1894), pl. xvii, figs. 1 *a*, *b*, *non* pl. xvi, figs. 2–4.

† "Ceph. d. Gosau-Sch.," 'Beitr. z. Pal. v. Österr.,' vol. i, 1858, pt. i, p. 10, pl. ii, figs. 4–6.

‡ *Loc. cit.*, p. 108, pl. xxiv, fig. 3.

§ "Kreide-Amm. v. Texas," 'Geol. und Pal. Abh. Koken,' N.F., vol. vi (1904), p. 31.

|| 'Recherches s. l. Craie Supér.' (1901), p. 379.

¶ *Loc. cit.*, p. 228, pl. xv, fig. 9.

** See above, p. 234.

†† *Loc. cit.* (1906), p. 336.

‡‡ *Loc. cit.* (1907), p. 250.

§§ "Die Bedeut. d. Südind. Kreideform., etc.," 'Jb. K.K.R.A.,' vol. xliv (1894), p. 464.

umbilicated *Schloenbachia* (*Prionocyclus*) forms that appear in the Lower Senonian," and to be closest to *A. paon*, Redtenbacher, and to *A. haberfellneri*, Hauer. The genus *Barroisiceras*, however, to which these two species belong, is characterised by a simplifying suture-line; and whereas its typical branch develops a concave periphery, another group (with acute periphery) tends towards certain Tissotids. Solger,* who doubtfully classed *A. umbulazi* in *Muniericeras*, appears to have been much nearer the mark. The young *A. umbulazi* reproduces the ornament of *Muniericeras lapparenti*, Grossouvre,† and has chevrons on the venter, but no keel (Fig. B 2). But before this stage, the young *A. umbulazi* reproduces *Puzosia*, with constrictions (Fig. B 3), and the suture-line throughout shows great resemblance to that of many Desmoceratids. There is, however, at least an equally great similarity, shown by the apparently continuous series *Sonneratia-Cleoniceras* and of *Hoplites-Pleurohoplites*‡-*Schloenbachia*§ with certain contemporary Desmoceratids; also, possibly, *Muniericeras* itself includes Prionotropid forms (Grossouvre's species, *M. gosauicum*, Hauer sp., *M. dresdense*, Petraschek) and Desmoceratid species, *e.g.* the lower Senonian *A. clypealis*, Schlüter and Brauns,‖ and "*Desmoceras*" *clypealoides*, Leonhard,¶ apparently connected with the Turonian *Puzosia hernensis*, Schlüter sp. Thus the presence of constrictions on the inner whorls of *P. umbulazi*, and a suture-line that resembles that of certain Desmoceratids, are not definite proof that *Pseudoschloenbachia* be derived from *Puzosia* rather than from *Prionotropidae*, viâ *Muniericeras*. Constrictions may appear in *Schloenbachia* as well as in *Pseudoschloenbachia* and *Gauthiericeras* and other genera (e.g. *Hystatoceras*, *Anahoplites*) apparently quite spontaneously, and one example of *Schloenbachia varians* in the writer's collection shows constrictions, like *Gauthiericeras fournieri*, Grossouvre sp., with deep chevrons across the venter, accompanied by decline of ornament and loss of keel.** At any rate, if comparison is at all permissible with the rather distant *Hauericeras*, a Desmoceratid

* "Foss. Mungokreide," 'Beitr. z. Geol. v. Kamerun, II' (1904), p. 205.

† *Loc. cit.* (1894), p. 158, especially pl. xxxv, fig. 3.

‡ Gen. nov. for *studeri* group, Jacob em. Spath (genotype, *A. renauxianus*, d'Orbigny, 'Pal. Franç. Ter. Crét.,' pl. xxvii).

§ *Varians*-group only.

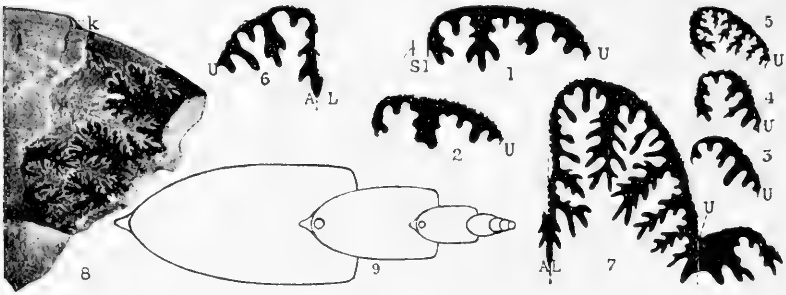
‖ de Grossouvre (*loc. cit.*, p. 175) has pointed out that Brauns' form is different from Schlüter's type.

¶ "Fauna d. Kreidef. Oberschles.," 'Palæontogr.,' xliv (1897), p. 57, pl. vi, figs. 2 *a*, *b*.

** This excludes any possibility of a connection between *Prohauericeras* or *Pseudoschloenbachia* and the true *Schloenbachia*.

genus with acute periphery, the group of "*Schloenbachia*" here discussed would be post-*Hauericeras*, not pre-*Hauericeras*, speaking phylogenetically, and irrespective of age—in other words, it would have travelled farther away from the Desmoceratid stock than *Hauericeras*.

Now Nowak* proposed the new genus *Prohauericeras* for those forms of *Schloenbachia* that showed a decided tendency in the direction of *Hauericeras*. The derivation of the latter genus from *Schloenbachia* (viâ *Prohauericeras*) can on no account be admitted. *Hauericeras* has a truly Desmoceratid suture-line, as a comparison of its internal sutures (Fig. A 7) with those of *Puzosia planulata* (Sowerby), Kossmat,†



Text-fig. A.—*Hauericeras gardeni*, Baily, sp. Umtamvuna River, Natal. (B.M. No. C 18528 [1–7 and 9] and C 18531 [8]). 1. Suture-line at diameter = 4 mm. SI = siphuncle; U = umbilicus. 2. Ditto at 6 mm., without external saddle. 3. Second lateral saddle and auxiliaries at 14 mm. D. 4. Ditto at 20 mm. D. 5. Ditto at 50 mm. D. 6. Internal (dorsal) suture-line at diameter = 6 mm.; AL = antisiphonal lobe; U = umbilicus. 7. Ditto at 50 mm. D, with second and third auxiliary saddles of external suture-line, and umbilical saddle (U). A.L. = antisiphonal lobe. 8. Whorl-fragment at D = 90 mm., K = hollow keel, on barely carinate venter of cast. (Photo. by G. C. Crick.) 9. Outline whorl-section at D = 75 mm., showing hollow keel and rounded inner whorls. All the figures are enlarged.

will show. The inner branch of the second lateral saddle, that is so conspicuous a feature of the development of the suture-line of *Hauericeras gardeni* (see Fig. A 1–5)‡ is similarly developed in many forms of *Puzosia* (e.g. *subplanulata*, Schlüter, *compressa*, *indopacifica*,

* "Unters. Ceph. Ob. Kreide Polen., III," 'Bull. Ac. Sci. Cracovie,' June, 1913, p. 370.

† *Loc. cit.* (1898), pl. xvi, fig. 4.

‡ The specimen (B.M. No. C18528) from which these figures were drawn, agrees in all respects with Baily's type (B.M. Geol. Soc. Coll., No. 11370), and the larger of the two fragmentary co-types (No. 11371) from which Baily's figure of the suture-line was taken. Some Japanese examples of *H. gardeni* in the British Museum (Geol. Soc. Coll.) also show this peculiarity of the suture-line, figured by various authors, in exactly the same manner.

Kossmat, *gaudama*, Forbes, etc.). When ornament appears in *Hauericeras* (*H. buszii*, var. *nodosa* and var. *costata*, Wegner*), it does so at a late stage; and the periphery of the cast is barely sharpened in *H. gardeni* at a diameter of 60 mm., which accounts for the fact that, *e. g.*, Pervinquière,† who, unlike Nowak, clearly recognised the hollow keel, found the casts of his small examples perfectly rounded.

The assemblage mentioned by Nowak includes Albian, Cenomanian, Turonian and Senonian forms and is most heterogeneous. Sharpe's *A. goupilianus* (*non* d'Orbigny) is only a smooth variety of *Schloenbachia varians*, Sowerby sp. Whiteaves' newly-created *Schl. propinqua* has as little to do with Stoliczka's earlier *A. propinquus*, as Anderson's *Schl. propinqua*‡ (Stol.), possibly a Turonian Prionotropid, is related to the Indian species. Such Albian forms as *A. acutocarinatus*, Shumard, belonging to the group of *A. roissyanus*, d'Orbigny, § again, are as little related to the true Cenomanian *Schloenbachia* or to "*Prohauericeras*," as the Neocomian *Oosterella cultrataeformis*, Uhlig sp., is to either.

Since *Prohauericeras* has been proposed, it may be convenient to retain it|| for *A. goupilianus*, d'Orbigny, which apparently was intended to be the type, since Nowak mentions it first, and refers to it again in connection with "*Schloenbachia*" *fournieri*, Grossouvre, and "*S.*" *obesa*, Stoliczka sp. In suture-line, as well as in other characters, this restricted *Prohauericeras* differs both from the true Cenomanian *Schloenbachia* and from its own (Turonian) contemporaries among the *Prionotropidae*. On the other hand, *Pseudoschloenbachia* is quite different again from any of these developments. Its internal suture-line (Fig. B 5 and 6) is figured for comparison with that of *Schloenbachia varians* (Fig. B 10); and it will be seen that it differs very considerably, especially from that of *Hauericeras*. As, however, more involute forms of *Puzosia* and other Desmoceratids, including the keeled "*P.*" *sugata*, Forbes sp., show, the stretching out of the auxiliary elements may only be the result of adaptation of a suture-line to wider sides, and the raising of the umbilical portion is often found in younger developments. The suture-line by itself thus is as unsatisfactory a character in many cases as, say, the carination would be, if taken as the only basis for classification.

* "Die Granulat. Kr. d. W. Münsterland.," 'Zeit. D. Geol. Ges.,' vol. lvii (1905), p. 208, pl. viii, figs. 1 *a* and *b*.

† *Loc. cit.* (1907), p. 165.

‡ *Loc. cit.* (1902), p. 123, pl. ii, figs. 34–38. Anderson (p. 63) also compared Whiteaves' "*S.*" *propinqua* with the Utatur form.

§ See under *Pseudophacoceras* (p. 283).

|| The name is no more unsuitable than is, *e. g.*, Frech's *Paralytoceras* for a Devonian Clymenid.

The hollow keel of *Hauericeras*, appearing comparatively late in ontogeny, cannot be a development of the solid keel of *Schloenbachia*, in which genus it appears after the costation, and, occasionally, tuberculation, and after the shell had become fairly involute. Similarly, the *ibex*-like periphery of the young *Pseudoschloenbachia* is not in favour of a possible connection of this genus either with *Schloenbachia* or with *Prohauericeras*. The various Natal forms indicate that this stock had its own involute and smooth developments (*P. griesbachi*, Crick MS.) and highly tuberculate and constricted forms (*P. papillata*, Crick MS.), and transitions between these extremes. There are oxycone developments with simplifying suture-lines (*Eulophoceras* and *Sphenisococeras*), and a hitherto unknown group (*Diaziceras*) that shows a superficial resemblance to the South American Lenticeratids, and is interpreted as a link connecting *Pseudoschloenbachia* with those genera (*Eulophoceras-Spheniscoceras*) that carry the simplification of suture-line and specialisation of whorl-shape to a higher degree. It is probable that these clearly allied forms are only indirectly connected with Desmoceratids, and that *Pseudoschloenbachia* viâ *Muniericeras* (and like *Gauthiericeras*, to which probably *S. bertrandi*, *S. fournieri*, Grossouvre,* and the forms of the Syrian Senonian have to be added) is derived from *Prionotropidae*.

8 and 9. PSEUDOSCHLOENBACHIA UMBULAZI, Baily sp.

(Pl. XX, figs. 2 and 3; Text-fig. B 2–7).

1906. *Schloenbachia umbulazi* (Baily). Woods, "Cret. Fauna of Pondoland," Ann S. Afr. Mus., vol. iv, part vii, No. 12, p. 336. (See there for synonymy.)

Two specimens are referred to this form, the smaller one (No. 5494) (Pl. XX, fig. 2) agreeing particularly well in costation with Baily's type-figure. Its dimensions are:

Diameter . . .	43 mm.
Height of last whorl .	51 per cent. of the diameter
Thickness ,, ,, .	28 ,, ,, ,,
Umbilicus . . .	13 ,, ,, ,,

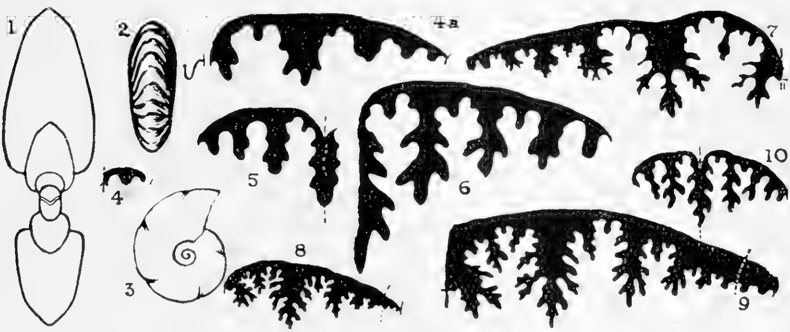
The larger specimen (No. 5459) is less coarsely costate at the same

* A specimen of "*Schloenbachia*" *boreaui*, Grossouvre, from the Middle Coniacian of the Charente Inferieure (B.M. No. C7387) shows that the group of "*S.*" *fournieri* is more nearly allied to *Gauthiericeras*, and has nothing to do with the probably Campanian *Pseudoschloenbachia*.

diameter, but develops the typical ornament, with distinct umbilical tubercles, on the outer whorl. It has the following dimensions:

Diameter . . .	59 mm.
Height of last whorl .	54 per cent. of the diameter
Thickness ,, ,, .	27 ,, ,, ,,
Umbilicus . . .	13 ,, ,, ,,

Both the specimens show the suture-lines well and have portions of the body-chambers preserved, the former rather less than the last half of the outer whorl, the larger specimen a little over half a whorl.



TEXT-FIG. B.—1. *Pseudoschloenbachia umbulazi*, Baily sp., Umtamvuna River, Natal (B.M. No. C19427). Sectional outline of inner whorls (at diameter = 32 mm.). 2–6. *Pseudoschloenbachia umbulazi*, Baily sp., Umkwelane Hill, Zululand (Specimen No. 5494) (p. 240). 2. Ventral aspect of inner whorls showing chevrons at D = 12 mm. 3. Lateral view of innermost whorls at D = 5 mm. 4. Ditto, suture-line at D = 2 mm. 4A. Ditto, suture-line at D = 4 mm.. 5. Ditto, internal suture-line at 4 mm. 6. Ditto, internal suture-line at 16 mm. 7. *Pseudoschloenbachia umbulazi* (Baily) var. *acuta*, nov. Suture-line of type-specimen (No. 5450) from Umkwelane Hill (p. 241). 8. *Pseudoschloenbachia griesbachi* (Crick MS.), Umtamvuna River, Natal (B.M. No. C19428). Suture-line of type-specimen at D = 60 mm. (reduced $\frac{2}{3}$). The edge should be minutely frilled. 9. *Aconeceras nisoides*, Sarasin, sp. Suture-line of specimen No. 5119 from Powell's Camp, Upper Catembe (p. 311). 10. *Schloenbachia varians* (Sowerby), Cenomanian, Warminster, Wilts. (Coll. L. F. Spath). Internal suture-line at diameter = 15 mm. All the figures except 8 are enlarged.

An immature third example (No. 5450) (Pl. XX, fig. 3) of 24 mm. diameter, and wholly septate, agrees with the first specimen described and with Baily's type-figure in the distinct costation,* but has a thinner section at an equal diameter and an acutely fastigate periphery. It may be separated as—

var. ACUTA, nov.

Mr. Woods stated that *P. umbulazi* appeared to be confined to Pondoland. In addition to the present specimens from Zululand,

* There is no tubercle on the ribs at the middle of the side, as might wrongly be inferred from the side-view given in Pl. XX, fig. 3.

there is an immature, evolute specimen from the Umpenyati River, Natal, recorded by Crick*; on the other hand, five specimens from the Umtamvuna River, Natal, in the British Museum, identified by Crick, represent more strongly ornamented varieties, with increasing tuberculation round the umbilicus. One of these examples (No. C19425) is slightly constricted and transitional to a highly tuberculate species named "*Schloenbachia*" *papillata* by Crick.

Specimens of the latter species, also of the transitional form, from Zululand and belonging to the Albany Museum, were sent to the writer in 1914 through the kindness of Mr. Woods, but since Crick had been at work on his paper on this fauna for many years, and since there were only a few specimens, they were not described. *P. papillata*, G. C. Crick MS. sp., is not represented in the present collection,† nor are the transitional forms, referred to above.

The three specimens were collected at Umkwelane Hill, Umfolozi, Zululand (Coll. Dr. A. L. du Toit).

Gen. DIAZICERAS, nov.

Genotype: *D. tissotiaeforme*, sp. nov., p. 245, Pl. XIX, figs. 1 *a–k*.

This genus is created for one form in the collection that cannot be included in any of the known genera of keeled Senonian Ammonites. Its suture-line stamps it as being near to the genera *Eulophoceras*, Hyatt, and *Spheniscoceras*, Crick MS.,‡ and in general outline this

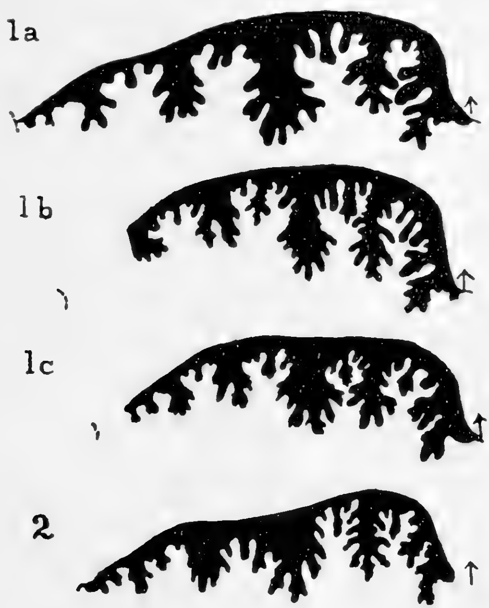
* *Loc. cit.* (1907), p. 250.

† Two additional specimens of this species were included in the collection from the Durban Museum, already referred to, and will be figured.

‡ This genus was created for the three species *S. africanum*, *S. minor* and *S. tenue*, G. C. Crick MS., which obviously are the "other species of *Eulophoceras*" referred to by Woods (*loc. cit.*, p. 337). Crick, in his diagnosis of the new genus, does not in any way mention the genus *Eulophoceras*, which, however, is very close, as will be seen on comparing the suture-lines given in Text-fig. C 1 with that of *Eulophoceras natalense*, Hyatt (Text-fig. C 2, after Woods, *loc. cit.*, pl. xlii, fig. 3), and with Hyatt's type (Pseudoceratites, 1903, p. 86, pl. xi, figs. 2–6). On the other hand, Crick considered the new genus to be "intermediate between *Placenticeras* and *Sphenodiscus*," which statement is meaningless, even from a purely morphological point of view, for *Spheniscoceras* has a thickened keel, after the style of that of the remarkable form figured as *A. roissyanus*, d'Orbigny, *varietas*, by Ooster (Catalogue, etc., 1860, pl. xxvi, fig. 7), or of certain *Dipoloceras* and *Pseudophacoceras* described in this paper (see, *e. g.* Pl. XXV, fig. 1 *d*, and Pl. XXVI, fig. 5 *b*), placed on a very thin and acute whorl. This is an exaggeration of the feature shown in Hyatt's fig. 6 *a* of pl. xi, but of doubtful generic importance. *Haueriseras rembda*, Forbes, shows a similar feature occasionally. In fact the writer is not convinced that Crick was right in

suture-line agrees with the South American *Lenticeras* and *Paralenticeras* included by Hyatt in the family *Eulophoceratidae.** These genera, however, include more or less smooth forms, whereas the new genus here proposed is characterised by strong ornament. The latter consists of very prominent umbilical tubercles, each connected by obscure broad ribs with about five outer tubercles. This type of ornament is found in the Senonian in certain *Pseudoschloenbachia* (*P. papillata*, G. C. Crick MS.), in *Barroisiceras* (*desmoulinsi*) and in certain Tissotids. The first genus has a highly complex suture-line, characterised by a very deep principal lobe, whereas the suture-line of the new genus shows signs of simplification in the peculiar rounding

separating the forms he described from *Eulophoceras*. *Eulophoceratidae* may be distantly related to the contemporary *Sphenodiscidae* (not the Turonian *Coilopoceratidae*, often confused with *Sphenodiscidae*), but there is no connection



Text-fig. C.—1. *Spheniscoceras*, G. C. Crick (MS.), Upper Senonian, Umtamvuna River, Natal. (After drawings, of the natural size, by the late G. C. Crick.) 1 *a*. *S. africanum*, Crick MS. (genotype), B.M. No. C19421. 1 *b*. *S. minor*, Crick MS. (B.M. No. C19422). 1 *c*. *S. tenue*, Crick MS. (B.M. No. C19423). 2. *Eulophoceras natalense*, Hyatt (after Woods), Pondoland. For comparison.

whatever between *Spheniscoceras* or any other Eulophoceratid and the *Placenticeratidae*.

* *Loc. cit.*, 1903 (Pseudoceratites), p. 16, also wrongly including *Tegoceras*, Hyatt, which is a Hystatoceratid.

of the terminal folioles, the short and simple lateral lobe, and the beginning development of adventitious lobes.

Barroisiceras includes shells (e. g. *B. desmoulinsi*, Grossouvre sp.) that are near the new genus in external shape, though less so in suture-line, and these forms with persistent keel, at any rate, may have to be excluded from *Barroisiceras*, since the typical group of this genus develops a concave periphery.

Tissotidae have a pseudoceratitic suture-line, quite different from that of the genus here described, though certain forms, e. g. *Metatissotia fourneli*, Bayle sp., somewhat resemble it in external shape. The earlier *Pseudotissotidae* have a less simplified suture-line, but cannot have given rise to a highly ornamented descendant in the Senonian such as the form here described.

Derivation from the main stock of the normally-lobed *Prionotropidae*, through *Pseudoschloenbachia*, is most probable, and it seems that whereas *Diaziceras* is nearer to the ancestral *Pseudoschloenbachia* in ornamentation, *Spheniscoceras* and *Eulophoceras* are, perhaps, closer to it in suture-line. It might be advisable to retain Hyatt's family *Eulophoceratidae* for these four genera, all presumably of Campanian age, but though there is a certain family resemblance with the suture-lines of *Eulophoceras* and *Spheniscoceras* (*cf.* Fig. C 1*a*) and less so with *Pseudoschloenbachia*, the similarity of the suture-line of *Diaziceras* with those of *Lenticeras*, *Paralenticeras* and other pre-Campanian genera makes it doubtful whether in the present state of our knowledge a subdivision of the Senonian *Prionotropidae* can yet be attempted. Moreover, an undescribed form, closely resembling "*Barroisiceras haberfellneri*" from Madagascar, as figured by Boule, Lemoine and Thévenin,* but possibly nearer to the Upper Chico "*Schloenbachia*" *chicoensis*, Trask sp. (Anderson†) occurs in Pondoland, associated with many Campanian species, but also with "*Puzosia*" *sugata*, Forbes sp., which occurs in the Lower Chico Beds of California, and in Lower and Upper Senonian beds in India and elsewhere. The likeness of these presumed Campanian forms with *Barroisiceras* may only be accidental, and since the median row of ventral tubercles in the new Pondoland form is very high and acute, it may well be assumed to lead from e. g. *Muniericeras* to *Pseudoschloenbachia* and *Diaziceras*. On the other hand, it looks as though a revision of the many forms of "*Schloenbachia*" in the Lower and Upper Chico Beds were most likely to throw light on the possible connection between *Diaziceras* and *Barroisiceras* on the one hand, and

* *Loc. cit.* ii (1907), p. 43, pl. xi, fig. 3.

† *Loc. cit.* (1902), p. 116, pl. ii, figs. 23–25.

Pseudoschloenbachia and *Gauthiericeras* and *Muniericeras* on the other.

The uncertainty as to the presence of pre-Campanian horizons in the Senonian of Pondoland and Umkwelane Hill is an additional difficulty. Though, thus, the close resemblance of the suture-line of *Diaziceras* with that of, e. g., *Lenticeras andii*, Gabb sp., and *L. baltai*, Lisson,* might be explained by the mechanical laws that govern the formation of the Ammonite-septum and its edge,† yet it is curious that as *Lenticeras* is associated with *Mortoniceras texanum*, so *Diaziceras* occurs together with the comparable *M. umkwelanense*, whereas the presence of *Peroniceras* in Zululand, and of "*Puzosia*" *sugata* and the above new form in Pondoland, suggests that the new genus may be closer to Coniacian genera than is here assumed. Unfortunately the writer has no comparable material for dissection.

10. Diaziceras tissotiaeforme, nov.

(Pl. XIX, figs. 1 *a–k*.)

This species is based on a completely septate specimen (No. 5478) having the following dimensions :

Diameter	80 mm.
Height of the last whorl .	50 per cent. of the diameter.
Thickness ,, ,, . .	59 ,, ,, ,,
Umbilicus	14 ,, ,, ,,

The small and deep umbilicus is surrounded by four very prominent tubercles, increasing in size with age, and each connected by faint ribs, with about five smaller rounded tubercles on the ventro-lateral edges. The prorsoradiate processes of these tubercles towards the very sharp ventral edge are very faint, so that the roof-shaped periphery is almost smooth. Where the shell is preserved on the ventral edge, near the end of the specimen, it follows the shape of the fastigate periphery of the cast, but at the beginning of the last whorl, where the peripheral character of the inner whorl is well shown, the shell rises in a distinct keel above the less acute ventral edge of the cast. The whorl section is polygonal, with the greatest whorl-thickness at the umbilical tubercles, and the two ventral and the two lateral faces concave, but the umbilical slopes convex.

* *Loc. cit.* (1908), pls. xiii and xiv.

† See the writer's "Notes on Ammonites," 'Geol. Mag.,' 1919, January to May numbers, and compare, *e.g.*, the suture-lines of *Pseudophacoceras* (Pl. XXV, fig. 1 *b* and *c*), and *Oxynoticeras* (Pia, 1914, pls. viii–xi), or of *Aconeceras nisoides* (Fig. B 9, p. 33) and *Pseudoschloenbachia griesbachi* (Fig. B 8).

There are twelve septa on the last whorl. .The most striking characteristics of the suture-line are the very deep external lobe and reduced first lateral lobe, the trifid external saddle and the peculiar rounding of the terminal folioles of all the saddles. These characters are found in the suture-lines of *Lenticeras andii*, Gabb sp., *L. baltai*, Lisson, and of *Paralenticeras sieversi*, Gerhardt sp.,* and of the two close allies—*Eulophoceras* and *Spheniscoceras*, which here are assumed to represent developments of the same stock. On the other hand, the suture line of "*Barroisiceras*" *desmoulinsi*, Grossouvre sp., as figured by Solger,† though showing a superficial likeness, differs considerably in its short external lobe, broad-stemmed external saddle and very simple outlines, even of the internal portion. This species, however, shows the greatest resemblance to the present species in its polygonal whorl shape. There are differences in ornament, but the important distinction is the presence of ventral tubercles in Grossouvre's form, which, when worn, may present the appearance of an entire keel. Solger's Cameroons specimens had an entire keel from the youngest stage, but differ from the Zululand example in proportions, ornament, and in having the peripheral tubercles elongated longitudinally. One of Solger's specimens also becomes quite rounded ventrally in the adult, so that these Coniacian forms may belong to quite a different stock from the presumably Campanian *Diaziceras*.

Pseudoschloenbachia papillata, G. C. Crick (MS.) sp., is a considerably thinner form, with eight umbilical tubercles, each corresponding to about four outer tubercles. It has a higher keel than is shown in the sectional views of *Gauthiericeras bertrandi* and of *G. fournieri* in Grossouvre,‡ and has much more prominent umbilical tubercles. But in *Pseudoschloenbachia* the suture-line is quite complex and characterised by a large and deep first lateral lobe. A comparison of fig. B 4*a* (p. 241) with fig. 1*k* of Pl. XIX will show that whereas *Pseudoschloenbachia* at 4 mm. diameter is much more advanced than *Diaziceras*, as regards elaboration of the septal edge, the latter genus shows a deeper ventral lobe, with the whole suture-line rising towards the umbilicus—generally a feature of later developments. The *Muniericeras* stage of *Pseudoschloenbachia* cannot be traced in *Diaziceras*, and it has already been pointed out that there is a possibility of the keel of these two genera being a development of the

* "Beitr. z. Kenntn. d. Kreideform. in Venezuela und Peru," in Steinmann, "Geol. und Pal. v. S. Amer.," V, 'N. Jb. f. Min., etc.,' Beil-Bd. xi, 1897, p. 82, text-fig. 6, and p. 79, text-fig. 5.

† *Loc. cit.* (1904), pp. 168 and 169, text-figs. 53 and 54.

‡ *Loc. cit.* (1894), pl. xxix, fig. 6*b*, and pls. xxxv, figs. 1*b* and 1*c*.

crenulated keel of certain Upper Chico forms that cannot safely be referred to such known genera as *Muniericeras* or *Barroisiceras*, and probably are later than either.

Locality.—Umkwelane Hill. Coll. Dr. A. L. du Toit.

Family: PLACENTICERATIDÆ.

Gen. PLACENTICERAS, Meek.

11. Placenticeras subkaffrarium, sp. nov.

(Pl. XXI, figs. 2 *a–d*.)

This species is based on a fairly well-preserved specimen (No. 5106) of the following dimensions:

Diameter	85 mm.
Height of last whorl . .	50 per cent. of the diameter
Thickness ,, ,, . .	37 ,, ,, ,,
Umbilicus	15 ,, ,, ,,

About one-half of the outer whorl belongs to the body-chamber, but the mouth-border is not preserved. The suture-line given in Fig. 2 *d* was taken at the beginning of the last whorl.

The species differs from *P. kaffrarium*, R. Etheridge fil.,* in having a smaller umbilicus (surrounded by tubercles that are very prominent already on the inner whorls, as shown in the umbilicus), in having a wider ventral area, and in the great thickness, caused by the prominent umbilical tubercles. The very conspicuous lateral ribs of *P. kaffrarium*, on the other hand, are not found in the example here described, but it should be mentioned that near the end of the specimen, where the shell has been removed, the lateral folds are more distinct on the internal cast than they are on the shell. The latter only shows very indistinct ribbing between the seven umbilical tubercles and the twenty-eight elongated outer prominences (unpaired) that border the flat and smooth ventral area. In addition to this distant ribbing, there are fine sigmoidal striæ, both on the shell, as in *P. tamulicum* (Blanford) Kossmat,† and on the cast of the body-chamber, as in *P. stantoni*, var. *bolli*, Hyatt.‡.

P. tamulicum, which, like the present species, belongs to the group of *P. syrtale*, Morton, is distinguished from the form here described

* *Loc. cit.* (1904, Second Report), p. 89, pl. iii, fig. 16.

† *Loc. cit.* (1895), p. 174, pl. xxii (viii), figs. 1 *a–c*.

‡ "Pseudoceratites of the Cretaceous," 'Mon. U.S. Geol. Surv.,' vol. xliv (1903), pl. xli, fig. 7, p. 214.

by being much thinner, by having more delicate ornamentation, a narrower siphonal area, with less prominent and closer nodes, and slight differences in the suture-line, *e. g.* the first adventitious lobe is smaller than the second one in *P. subkaffrarium*, whereas the reverse proportions are noticeable in the Indian species.*

P. stantoni, var. *bolli*, Hyatt,† also is a close ally of the present species, as is *P. intermedium*, Johnson,‡ the latter only distinguished from the Zululand form by a narrower ventral area and a wider umbilicus.

Locality.—Umkwelane Hill, Umfolozi, Zululand. Coll. J. S. Hedges.

Family: NOSTOCERATIDÆ.

Gen. NOSTOCERAS, Hyatt.

12. Nostoceras ? natalense, sp. nov.

(Pl. XXII, figs. 2 *a*, *b*.)

A depressed turricone (No. 2746) with the apical portion missing, like the somewhat similar *Didymoceras ? newtoni*, Whitfield sp., cannot definitely be referred to either *Didymoceras* or *Nostoceras* until more complete specimens are known. The example is distinct enough, however, to justify a new specific designation.

The two and a quarter whorls preserved are septate throughout, and though the suture-lines are too indistinct for delineation, they appear to be of the same general plan as that of *Nostoceras ? subangulatum*, nov., with the external lobe and its small median (siphonal) saddle between the two rows of tubercles. These are very prominent, elongated, and continued on the under surface of the whorls into simple and strongly forwardly inclined ribs, somewhat like those of *D. umbilicatum*, Meek,§ but more oblique, and with a very steep backward edge. On the upper surface of the whorls the costae bifurcate at the tubercle, as in *D. ? tricostatum*, Whitfield,‖ which Hyatt¶ considered to be the possible gerontic stage of *D. ? newtoni*.

* *P. syrtale*, Morton, var. *tamulicum* (Blanford), Kossmat in Boule, Lemoine and Thévenin (*loc. cit.*, II, 1907, p. 47, pl. xii, figs. 3 and 4), is very close to the Zululand specimen, but apparently possesses the outer tubercle of *P. syrtale*.

† *Loc. cit.*, "Pseudoceratites," 1903, as above, also, *e. g.*, pl. xliii, fig. 1.

‡ 'The Geol. of the Cerrillos Hills, New Mexico,' part ii, 'Palaeont.,' School of Mines Quarterly, vol. xxiv, no. 2, 1903, p. 206, pl. viii, figs. 27 *a*, *b*.

§ "Invert. Cret. and Tert. Foss.," 'U.S. Geol. S. Territ.,' vol. ix (1876), pl. xxii, fig. 5.

‖ "Pal. Black Hills, Dakota," 'U.S. Geol. S.' (1880), pl. xv, fig. 7.

¶ "Phylogeny of an Acquired Characteristic," 'Proc. Am. Phil. Soc.,' vol. xxxii (1894), p. 574.

Only in the Zululand species, there generally is only a thick posterior and a fine anterior branch, without the intermediaries found in both the Dakota forms. The new form of *Didymoceras*, figured by Schlüter on pl. xxxv, figs. 1–4, as *Heteroceras polyplocum* ?, showing bifurcation only, is, perhaps, closer to the form here described in this respect, but the tubercles are far too fine. The whorl-section is as compressed as that of Schlüter's loosely coiled form,* and less rounded than that of *D.? newtoni*, which has a larger umbilicus. That of the present species is as small as the umbilicus of *D. pauper*, Whitfield sp., or that of *D. archiacianum*, d'Orbigny sp., which latter also shows a similar forward sweep of the costation on the under surface.

Since the apex of the spire is not preserved, it is impossible to state whether the early whorls were closely coiled, as seems probable from the presence of a contact furrow on the upper surface of the highest whorl, or whether the apex was an irregular spiral, as is the case in so many forms of this group (*Didymoceras*). The coiling of the portion that is preserved is the same as that of *Turrilites acutus*, Passy, also recorded from Zululand by Crick.† "*Turrilites*" *tridens*, Schlüter,‡ also shows similar coiling, but the drawing appears deceptive, and the writer is inclined to consider this species to belong to *Hyphantoceras*, to judge by the under-surface of the whorls.§

If the form here described is a *Nostoceras*, it probably represents a less specialised type than *N. stantoni*, Hyatt‖; for the single costae with two lines of tubercles, so characteristic of *Exiteloceras*, are found in the young of *Nostoceras stantoni* and of *N. helicinum*, Shumard sp.¶ The latter form has a very short spire like the Zululand form, with a deeply impressed suture, but the costation is quite different.

Locality.—Umfolozi Valley, East of Railway. Coll. Mr. Illingworth.

* This shows close resemblance to a beautiful specimen of *Emperoceras simplicostatum*, Whitfield sp. (larger than the example figured by Whitfield, 'Bull. Am. Mus. Nat. Hist.,' vol. xvi, 1902, pl. xxvii), in the B.M. (No. C10808), and though the earlier whorls apparently are quite different from those of *Nostoceras* and *Didymoceras*, the ornament of the last volution strikingly recalls that of *D? newtoni*, Whitfield sp., and of *D? cooperi* (Gabb) Whiteaves (B.M. from Vancouver).

† *Loc. cit.* (1907), p. 176, pl. xi, figs. 3 and 4.

‡ *Loc. cit.* (1872), pl. xxxv, fig. 9.

§ The trituberculate (?) *Turrilites peramplus* Lasswitz (*loc. cit.*, p. 14, pl. ii, fig. 1) also resembles the present form somewhat in shape, but may be a true *Turrilites*, though Lasswitz compares it with Schlüter's "*Turrilites*" *tridens*.

‖ *Loc. cit.* (1894), p. 570.

¶ "Descr. of New Cret. Foss. from Texas," 'Proc. Boston Soc. Nat. Hist.,' vol. viii (1861), p. 190.

13. Nostoceras? subangulatum, sp. nov.
(Pl. XXII, figs. 3 *a–c*.)

A sinistrally coiled, fairly elevated but fragmentary turricone (No. 2746a), consisting of just over two whorls of body-chamber and of a small portion of the septate and possibly more loosely coiled earlier whorls, is doubtfully referred to the genus *Nostoceras*. There is great resemblance to the dextrally coiled *Didymoceras? stevensoni*, Whitfield sp.,* and the helicoid character of the earlier whorls, if proved by the discovery of more perfect examples, may necessitate the transfer of the new form to the genus *Didymoceras*; on the other hand, the beginning of the example here described already shows an impressed zone of contact, so that the reference to *Nostoceras* seems most proper. Like the species last described, the present example with its strong, simple costation and double row of ventral tubercles recalls the ornamentation of the genus *Exiteloceras*, and the fragment of *Ex. angulatum* figured by Meek,† shows a close resemblance to the septate portion here described, though there is a considerable difference in size. The openly helicoid or irregular coiling of the young of *Exiteloceras*,‡ however, is quite distinct.

The whorl-section is almost rounded, except for the double row of tubercles on the ventral area, slightly below the middle, and the impressed zone on the upper surface, indicating affinity with *N. stantoni* and "*N.?*" *cf. stevensoni* (Whitfield) in Hyatt.§ The costation is very irregular; on the small septate portion, the costae have a very steep forward edge and a gentle slope backward, and are continuous between the slight tubercles. On the under-side they are projected strongly forward, towards the umbilicus, as in the basal view of *Didymoceras? stevensoni*, Whitfield sp.|| On the upper surface they describe first a backward curve, and then, in the contact furrow,

* "Note on a Very Fine Example of *Helicoceras stevensoni*, etc.," 'Bull. Am. Mus. Nat. Hist.,' vol. xiv (1901), p. 219, pls. xxix and xxx.

† *Loc. cit.*, 1876, p. 484, pl. xxi, fig. 3 (perhaps a fragment of a *Didymoceras?*).

‡ Hyatt (*loc. cit.*, p. 577) calls *Hamites fremonti*, Marcou (holotype in B.M., Geol. Soc. Coll., No. 12667), probably a gerontic stage of some species of *Exiteloceras*, which is doubtful, the former probably being of Albian age, and close to "*Anisoceras alternatum*," Pict. & Camp. *non* Mantell (*loc. cit.*, 1861, pl. li). *Helico. pariense*, White, also, in the writer's opinion, is not an *Exiteloceras*, and with the so-called "*Crioceras ellipticum*, Mantell," of Schlüter and other authors, and similar Turonian forms, belongs to a new, unnamed genus.

§ *Loc. cit.* (1894), pp. 568 and 571.

|| *Loc. cit.* (1880), pl. xiv, fig. 7, and *loc. cit.* (1901), pl. xxx. This form seems to differ from the species here described only in the uncoiling of the body-chamber.

a reverse curve that is strongly convex forwards. A somewhat similar costation is shown on the upper whorl-surface of *D. pauper*, Whitfield sp.,* and of *D. ? conradi*, Morton sp., in Whitfield.†

The elongated tubercles, situated at each side of the siphonal zone (which latter becomes almost smooth towards the end of the shell) are small on the septate portion, but 4 mm. high and very sharp, where preserved on the last whorl. There is only one untuberculate intermediate rib here and there, as on the last whorl of *D. ? stevensoni*, but the bituberculation is rather irregular as regards spacing.

The suture line shows good agreement with that of *Didymoceras tortum*, Meek sp.,‡ except that the latter, taken at a larger diameter, shows correspondingly greater complication. There is the same high external lobe; only in the present form the siphonal line lies between the two rows of tubercles, which are placed more centrally. The principal lateral lobe shows a similar smaller outer and larger inner branch; the lateral saddle is equally bifid, the smaller second lateral lobe is bifid in the two forms, and the arrangement of the dorsal lobe and saddles is very similar. In *D. ? stevensoni*, the very complex suture-line, taken at a much larger diameter, shows a different development of the principal lobe, the outer branch being the larger. The suture-line of *D. pauper* (Whitfield) also is very similar to that here figured, and the whorl-section agrees, but the costation is different.

D. hornbyense, Whiteaves sp.,§ a form somewhat resembling *D. ? binodosum*, Hauer sp.,‖ is much more finely costate than the specimen here described, to judge by an example from Vancouver Island in the British Museum,¶ and other specimens of *Didymoceras* in the same collection from the Upper Missouri, etc., differ in the same respect.

* *Loc. cit.* (1892), pl. xlv, fig. 3.

† *Ibid.*, pl. xlv, fig. 10.

‡ *Loc. cit.* (1876), p. 481, pl. xxii, fig. 4 *c*.

§ *Loc. cit.* (Mesoz. Foss. I), p. 332, pl. xlii, figs. 1–4.

‖ "Neue Ceph. a. d. Gosaugeb. d. Alp.," 'Sitz. B. K. Akad. Wiss.,' vol. liii (1866), p. 8, pl. i, fig. 6. This, however, may be a *Bostrychoceras*.

¶ This was labelled by Kossmat "*Heteroceras* sp. aff. *cooperi*, Meek," whereas another example of a *Didymoceras*, corresponding somewhat to Whiteaves' *A. cooperi* (*loc. cit.*, pl. xliii, fig. 1), but not with Meek's specimen or Gabb's fragment (the latter compared with *Emperoceras* by Hyatt, *loc. cit.*, p. 576), was wrongly labelled by Kossmat "*Acanthoceras vancouvrensis*, Meek." In form and costation this second fragment recalls *D. ? conradi* (Morton), Whitfield sp., and *Emperoceras simplicostatum*, Whitfield sp., but there is also a striking resemblance of the looped tubercles with the ornament of *Jacobites anderssoni*, Kilian and Reboul (*loc. cit.*, 1909, p. 35, pl. viii, fig. 3).

On the other hand, there is a superficial resemblance to certain Albian *Turrilites*, e.g., *T. circumtaeniatus*, Kossmat,* or *T. catenatus* (d'Orbigny),† but not to Cenomanian species. The suture-line, however, is placed differently in these true *Turrilites*, and in the writer's opinion the *Nostoceratidae* cannot be considered to be descendants of the earlier *Turrilitidae*. The grouping of the uncoiled forms of the Senonian may be provisional and more or less unsatisfactory in the present state of our knowledge; but we must reject Nowak's ‡ opinion that the Senonian "*Heteroceras*" ("*Helicoceras*" is a strictly Albian development), can, with the Aptian true *Heteroceras*, be considered to belong to one branch of uncoiled Parahoplitids.

Locality.—Umfolozi Valley, East of Railway. Coll. Mr. Illingworth.

GEN. BOSTRYCHOCERAS, Hyatt.

14. BOSTRYCHOCERAS? sp. nov.

1906. *Heteroceras* sp. Woods: "Cret. Fauna of Pondoland." Ann. S. Afr. Mus., vol. iv, part vii; No. 12, p. 339, pl. xlii, fig. 5 *a*, *b*.

This form is represented in the collection by several fragments. One of these (No. 5477) about 35 mm. in length, with almost circular cross-section (long and short diameters 12 mm. and 11·5 mm. respectively) corresponds with the figured example; another larger fragment of 16 mm. diameter and about 40 mm. length (No. 5476), like the impression of a third and still larger example (No. 5477A), appear to have some of the ribs more pronounced than others, so that it would seem as though, at a larger diameter, this form develops costation like that of the *Bostrychoceras* sp. ind. next described and compared with certain flared Japanese forms. The ribbing of the examples under discussion, however, is of quite a peculiar character. The inner shell, like the cast of the interior, only shows very indistinct costation. The second layer forms a broad and flat septum at the base of each rib and slight concavities in between these septa. The

* *Loc. cit.* (1895), p. 141, pl. xviii, figs. 4 and 5. Kossmat renamed Stoliczka's *Turrilites brazoensis*, since it does not agree with Roemer's type, which Kossmat considered to be Lower Senonian. Whether Kossmat's example (p. 142 (46), pl. xx, fig. 4), agrees with the quadrituberculate Texas species may be doubtful, but *Turrilites brazoensis* is a true Cenomanian *Turrilites*, occurring in the Upper Denison Beds (Grayson Formation), about 200–300 ft. above the horizon of *Subschloenbachia leonensis*, probably of *rostrata* (s.l.) date. (R. T. Hill, "Geogr. and Geol. Black and Grand Prairies, Texas," '21st Ann. Rep. U.S. Geol. S.' (1901), p. 247).

† 'Pal. Franç., Ter. Crét.,' vol. i, pl. cxl, figs. 1–3.

‡ *Loc. cit.* (1913), p. 379.

third layer is very thin between the ribs, but apparently continuous with the material deposited on the rib-bases and forming comparatively high and very sharp ridges, and the whole is covered by a fourth outer layer of shell. Where the acute costation is worn off, the septate rib-bases show as illustrated in Wood's fig. 5 *a*.

Woods compared the form with Stoliczka's *Heteroceras indicum*, which is considered by various writers to be identical with, or closely allied to, *Bostrychoceras polyplocum*, Römer sp., but which, like *Turrilites saxonicus*, Schlüter, may be a *Hyphantoceras*, not a *Bostrychoceras*. On the other hand, the small constricted specimen figured as *Helicoceras indicum* ? by Anderson* and which is not identical with the Indian species, shows open coiling similar to the South African form, but it also may be a *Hyphantoceras*.

Of the many forms included in *Bostrychoceras polyplocum* (Römer) by Schlüter,† that figured on pl. xxxv, fig. 8, or the evolute form figured by Geinitz‡ may belong to species allied to the South African examples. *B. ? declive*, Gabb sp.,§ *B. japonicum*, Yabe sp.,|| further, the whorl-fragments figured by Jimbo¶ as "*Turrilites* sp." and by Meek**

* "Cret. Depos. of the Pacific Coast," 'Proc. Calif. Acad. Sci.,' 3rd ser., Geol. II, i, p. 91, pl. iii, figs. 96 and 97.

† A specimen of a *Bostrychoceras* sp. n., in the British Museum (No. 74042) from Haldem in Westphalia, comparable with Schlüter's pl. xxxiii, figs. 6 and 8, from the same locality (*Heteroceras polyplocum* (A. Römer) in Schlüter) has a costate early portion, then a constriction, and a bituberculate final portion. This form and, perhaps, more so Schlüter's fig. 1 of pl. xxxiv, then *Bostrychoceras ? carlottensis*, Whiteaves sp. (*loc. cit.*, p. 271, pl. xxxiv, fig. 1) and *B. ? oshimai*, Yabe sp. (*loc. cit.*, 1904, p. 12, pl. iii, figs. 5 and 6, which, however, may be a *Hyphantoceras*), show close resemblance in ornamentation to certain *Didymoceras*, e.g. *D. nebrascense*, Meek sp. (B.M. No. 83907 from Upper Missouri), and *D. hornbyense*, Whiteaves (B.M., Hector Collection from Vancouver Island). The separation of fragmentary examples of the two genera *Bostrychoceras* and *Didymoceras*, based only on tuberculation and mode of coiling, seems somewhat artificial, as a comparison of such typical forms of *Didymoceras* (in Hyatt) as *D. cochleatum* and *D. tortum*, Meek sp., with some of the tuberculate varieties of *B. polyplocum* in Schlüter will demonstrate. The suture-lines, also, are of a similar pattern in the whole family *Nostoceratidae*.

‡ "Das Elbthal-Geb. i. Sachsen," II, 'Palæontogr.,' vol. xx (1872–5), p. 195, pl. xxxvi, fig. 3 only. ("*Turrilites polyplocus* var. of *Helicoceras* type.")

§ 'Pal. of California,' vol. i, p. 73, pl. xxviii, figs. 200, 200 *a*. Upper Chico in Anderson, *loc. cit.* (1902), p. 27, Maestrichtian in Haug, 'Traité,' p. 1347.

|| "Cret. Ceph. from the Hokkaido," 'Jl. Coll. Sci. Imp. Univ. Tokyo,' vol. xx (1904), p. 17, pl. iii, fig. 8.

¶ "Beitr. z. Kenntn. d. Kreidef. v. Hokkaido," 'Pal. Abh.,' vol. vi (1894), p. 41, pl. i, fig. 8.

** *Loc. cit.* (1876), pl. xxi, fig. 4.

as "*Heteroceras*? sp. ind.," agree with the specimens here described in whorl-shape and coiling, but all have oblique costation.

A fragment of a "*Heteroceras* sp.," from the "Iron Mines of Hokkaido, Japan" (B.M., No. C10410B) resembles the South African form in coiling and whorl-section, and being a cast, in the faint ribbing, but it is considerably larger. Its suture-line is "lytoceratid," like that of *Pravitoceras sigmoidale*, Yabe,* which it closely resembles, and it is associated with fragments comparable with the inner, closely coiled whorls of *Pravitoceras*† and with the terminal portion of such a species of *Bostrychoceras* or *Didymoceras*, as, *e.g.*, the variety of "*Heteroceras polyplocus*" figured by Schlüter on pl. xxxiv, figs. 2 and 3, or *D.? cooperi*, Gabb, in Whiteaves.‡ The age of *Pravitoceras* unfortunately is not known, but it is to be noted that the suture-line of the South African form, figured by Woods, and that of the Turonian *Hyphantoceras*, are very similar to that of *Pravitoceras*, and the writer is of opinion that the resemblance of all these to the suture-line of *Lytoceratidae* is a case of convergence, correlated with the rounded whorl-shape. *Nipponites*§ also represents a development related to the loosely-coiled *Bostrychoceras* here discussed, but the reference of the South African form to this genus cannot, of course, be considered definite so long as only fragmentary specimens are available. The young of *Emperoceras*‖ show hamitid, helicoid coiling, and the twisted form figured by Woods¶ as *Hamites* (*Anisoceras*), sp., seems to form a transition to such species as "*Ancyloceras*" *retrorsum*, Schlüter, and to the group of "*Anisoceras*" referred to in the description of *Diplomoceras? indicum*, which groups stand in the same relationship to *Bostrychoceras* as (ptychoceratid, hamitid or ancyloceratid) *Oxybeloceras*** does to *Exiteloceras*. The similarity, however, of the

* "Note on Three Upper Cretaceous Ammonites etc.," 'Jl. Geol. Soc. Tokyo,' vol. ix (1902), No. 100, p. 3, pl. i, figs. 2–4.

† *Ibid.*, fig. 3.

‡ *Loc. cit.*, p. 336, pl. xliii, fig. 1.

§ Yabe, *loc. cit.* (1904), p. 20, pl. iv, figs. 4–7, pl. vi, fig. 6.

‖ Hyatt, *loc. cit.* (1894), p. 575, pl. xiv, figs. 15–17.

¶ *Loc. cit.*, p. 340, pl. xliv, fig. 3.

** Unless new genera are introduced again for the different forms of coiling, such species as "*Hamites*" *wernickei*, Wollemann ("Fauna d. Lüneburger Kreide," 'Abh. K. Preuss, L A.,' N.F., Heft. 37 (1902), p. 95, pl. iv, fig. 4, and pl. v, figs. 1 and 2—crushed?), or "*Ancyloceras*" *bipunctatum*, Schlüter (*loc. cit.*, p. 98, pl. xxix, figs. 1–3), will have to be included in *Oxybeloceras*, whereas "*Crioceras*" *plicatilis*, Kner, *non* Sowerby (Lemberg, 'Naturw. Abh.,' iii, 1850, pt. 2, p. 9, pl. ii, fig. 3) = *Helicoceras schloenbachi*, Favre ('Moll. Craie, Lemberg,' 1869, p. 30, pl. vii, figs. 5 *a–c*), and *Helicoceras hibernicum*, Tate, possibly belong to *Exiteloceras*. The presence of at least one other unnamed group is indicated by

young of *Emperoceras simplicostatum*, Whitfield sp., to *Oxybeloceras* shows that the interrelations of these genera are very complicated, and that the determination of mere fragments is very difficult.

Locality.—Umkwelane Hill. Coll. Dr. A. L. du Toit.

15. Bostrychoceras? sp. ind.

(Pl. XXIV, fig. 2.)

An impression (No. 5478A) of a whorl-fragment of a form allied to the *Heteroceras* sp., figured by Woods* but with only three, not four, intermediate ribs and the flares much closer together, is doubtfully referred to the genus *Bostrychoceras*. In a length of about 40 mm. there are six of these flares, as against four in the Pondoland example. This closeness of the costation approaches the form to "*Helicoceras* (?)" *venustum*, Yabe† and "*Helicoceras*" *scalare*, Yabe,‡ but these have more numerous intermediary ribs and may possibly belong to *Hyphantoceras*. The peripheral portion of the impression here described, and its whorl-section being unknown, comparison with "*Helicoceras*" *breweri*, Gabb,§ and "*Crioceras* (?)" *cingulatum*, Schlüter,|| is difficult. They also represent similar fragments with flares, apparently connected with the typical *Bostrychoceras* by such forms as *B. japonicum*, Yabe sp.¶

Locality.—Umkwelane Hill. Coll. Dr. A. L. du Toit. (Impression in matrix of specimen 5478 = *Diaziceras tissotiaeforme*, nov.)

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such forms as "*Hamites*" *phaleratus*, Griepenkerl ("Verstein. d. Senon. Kreide v. Königslutter," 'Pal. Abh.,' vol. iv (1889), Heft 5, p. 104, pl. xi, fig. 3, and pl. xii, figs. 3 and 4), "*Ancyloceras*" *pseudo-armatum*, Schlüter (*loc. cit.*, p. 164, pl. xliii, figs. 8 and 9, ? 5–7), and "*Ancyloceras*" *kossmati*, Simionescu ("Fauna Cret. Sup. d. l. Ürmös," 'Acad. Romana,' Publ. Fd. Vasilie Adamachi, No. 4 (1899), p. 21, pl. i, figs. 6–8). A beautiful, but fragmentary, example of a new form of this group, comparable with "*Hamites*" *quadrinodosus*, Jimbo sp., from the Umzamba beds of Pondoland (Coll. Geol. Survey), was sent to the writer, after the completion of this paper, through the kindness of Mr. Henry Woods. The Durban Museum Collection, already referred to, also includes *Oxybeloceras* ? sp., cf. *interruptum*, Schlüter, and *wernickei*, Wollemann sp.; further, several gen. nov. (*Hyphantoceras*?) cf. *spinigerum*, Jimbo sp., all from the Pondoland Senonian.

* *Loc. cit.* (1906), p. 339, pl. xlii, fig. 4.

† *Loc. cit.* (1904), p. 11, pl. iii, fig. 4.

‡ *Ibid.*, p. 9, pl. iii, figs. 2 and 3.

§ *Loc. cit.*, vol. i, p. 72, pl. xiv, fig. 22 (Upper Chico in Anderson, p. 27).

|| *Loc. cit.*, p. 101, pl. xxx, figs. 13 and 14.

¶ *Loc. cit.*, p. 17, pl. iii, fig. 8.

Gen. DIPLOMOCERAS, Hyatt.

16. Diplomoceras? indicum, Forbes sp.

(Pl. XXIII, fig. 5.)

1895. *Hamites (Anisoceras) indicus*, Forbes. Kossmat. Südind. Kreidef. Beitr. z. Pal. und Geol. Öst.-Ung. etc., vol. ix, p. 145, pl. xix, fig. 4.

1906. *Hamites (Anisoceras) indicus*, Woods. Cret. Fauna of Pondoland, p. 340, pl. xliv, fig. 2.

This form is represented in the collection by a fragment (No. 5465) that corresponds with Kossmat's fig. 4*a*; but the hooked portion forms the smaller end, not the larger, as in Kossmat's figured example. The last few suture-lines, shown on the hooked portion of the shell, are of the general outline of that of *D.? indicum* as figured by Kossmat, but have a less minutely frilled edge. The costation is closer than it is in the fragment figured by Woods, but not so close as in Kossmat's specimen or in *D.? rugatum* (Forbes), Kossmat sp., the cross-section of which latter species, also, is more elliptical. The costation is very sharp and not septate, *i. e.* the ribs are as acute on the cast as they are on the shell. One of the ribs is higher than the others (about 1·5 mm. high, measured from the concavity at each side, at a whorl-diameter of 9 mm.). Specimens of *D.? large-sulcatum*, Forbes sp., and *D.? rugatum*, Forbes sp., in the British Museum show similar irregularities, as does the Japanese form, figured as "*Hamites* sp.," by Jimbo* and compared with *D.? large-sulcatum* by Kossmat.† The costation is too distant, however, in the latter species, as it is in the small fragment of a "*Hamites*" from Umkwelane Hill figured by Etheridge.‡ This was compared with Griesbach's *Anisoceras rugatum*, Forbes sp., from the Umtamvuna Beds (a form that was included by Woods in the synonymy of *D.? indicum*), but probably is nearer to *D.? large-sulcatum*, Forbes sp.

Such species as *D. obstrictum* Jimbo sp.,§ and *D. ellipticum*, Anderson sp.,|| seem to form a connection with the typical gigantic *Diplomoceras* of the *cylindricum* and *notabile* group, but with increased knowledge of these forms it will probably be necessary to separate from the highly specialised *Diplomoceras* the Indian "*Anisoceras*"

* *Loc. cit.* (1894), p. 40, pl. vii, fig. 7.

† *Loc. cit.* (1895), p. 147.

‡ *Loc. cit.* (Second Report, 1904), p. 90, pl. iii, fig. 23.

§ In Whiteaves, *loc. cit.*, p. 334, pl. xliv, fig. 3.

|| *Loc. cit.*, 1902, p. 87, pl. iii, figs. 102–3.

assemblage on the one hand, which connects directly with the loosely coiled *Bostrychoceras* above described, and on the other the various European "*Hamites*" ("*H.*" *roemeri*, Geinitz), "*Toxoceras*" (*T. aquisgranensis*, Schlüter), "*Ancyloceras*" (*A. retrorsum*, Schlüter) of slightly earlier date and simple suture-line. Whether these Campanian "Hamitids" are ancestral to the Maestrichtian *Diplomoceras* and what their relationship is to the contemporaneous "*Ptychoceras*" and *Solenoceras* it is for future investigation to determine. It may be added that a form indistinguishable from the Maestrichtian *Diplomoceras cylindricum*, d'Orbigny sp., occurs in the Cambridge Greensand (Uppermost Albian), but the writer is convinced that this is only a case of convergence, and that even the Turonian "Hamitids" should be separated generically from the Senonian forms. The last true *Hamites* are comparatively rare in the Cenomanian.

Locality.—Umkwelane Hill. Coll. Dr. A. L. du Toit.

Family: BACULITIDÆ.

Gen. BACULITES, Lamarck.

17. Baculites capensis, H. Woods.

(Pl. XXIV, figs. 6 and 7.)

1906. *Baculites capensis*, Woods. "Cret. Fauna of Pondoland," Ann. S. Afr. Mus., vol. iv, part vii, No. 12, p. 342, pl. xliv, figs. 6 and 7.

? 1907. *Baculites vagina*, Forbes in Boule, Lemoine & Thévenin. "Céph. Crét. Diego-Suarez," Ann. de Pal., vol. ii, p. 65, pl. xv, fig. 3.

This is the commonest cephalopod at Umkwelane Hill, sixteen examples being referred to this species, in addition to a number of fragments in the matrix of other fossils. The young is merely striate, like *B. bailyi*, and the nodes first appear where the long diameter is about 8 mm.

Woods compares the species with *B. asper* as figured by Morton, Römer and Stanton, the last probably of Turonian age. The less coarsely nodate form figured by Meek,* and a specimen of this in the British Museum from "Mississippi" are very close to the South African species in all characters but the suture-line.

Some of the larger examples (No. 5479A, 5403) seem to develop coarser striation on the siphonal side, much like the example here compared with *B. sulcatus*, Baily. The suture-line differs rather

* *Loc. cit.* (1876), p. 404, pl. xxxix, fig. 10*a* only.

considerably from that of *B. incurvatus*, Dujardin,* and is closer to that of *B. fairbanksi*, Anderson,† characterised by broad and low saddles and small lobes. *B. vagina*, Forbes, has an entirely different suture-line ‡; and in that of the probably Turonian *B. gracilis*, Shumard, in Stanton,§ which also is comparatively simple, the lateral saddle is too high and too narrow, and the second lateral lobe too deep. On the other hand, the suture-line figured by Boule, Lemoine and Thévenin ‖ as that of *Cyrtocheilus baculoides*, Mantell sp., agrees very well with that of the South African species, and that of *B. bohemicus*, Fritsch and Schloenbach,¶ also is very similar.**

The form figured by Boule, Lemoine and Thévenin †† as *Baculites vagina* (Forbes), var. *otacodensis* Kossmat, seems to agree much more with Woods' species than with the Indian form.

Localities.—Nos. 5479, 5443, 5490, 5454, 5470, 5458, 5474, 5484 (pars), 5486, 5408, 5475, 5479A and 5403 from Umkwelane Hill. Coll. Dr. A. L. du Toit. No. 4832 from Railway Cutting, Umfolozi. Coll. W. J. Wybergh. No. 5108 from Umkwelane Hill. Coll. J. S. Hedges.

18. Baculites sp. aff. capensis, H. Woods.

A number of poorly preserved specimens (5484 (pars), 5479B, 5509B) are comparable with the fragment figured by Etheridge ‡‡ from Umkwe-

* In Schlüter (after Geinitz), *loc. cit.* pl. xl, fig. 3.

† *Loc. cit.* (1902), fig. 194, pl. x, p. 92.

‡ The suture-line in Steinmann (Quiriquina, *loc. cit.*, 1895, p. 91, text-fig. 8), is different from that of Forbes' type (B.M. No. R10488, Geol. Soc. Coll.) and of Indian specimens in the writer's collection.

§ *Loc. cit.* (Col. Form., 1893), p. 166, pl. xxxvi, fig. 2. See also Solger (*loc. cit.*, Kamerun, 1904), text-fig. 4, on p. 102.

‖ *Loc. cit.*, II (1907), text-fig. 29, on p. 65.

¶ In Schlüter, *loc. cit.* ii, 1876, fig. 5 on pl. xxxix.

** The suture-lines of the varieties *valognensis* and *leopoliensis* of *B. anceps* (Nowak, "Untersuch. Poln. Kreide.," I, *Baculites*, 'Bull. Ac. Sci. Cracovie,' 1908, p. 331, text-figs. 1–4 and 5–10) are of the same type, but with a more complex ventral lobe. The suture-line (drawn by the late G. C. Crick) of a Pondoland example (B.M., No C19420), represented in fig. 7 of Pl. XXIV, is characterised by a wider inferior lateral lobe than that of the specimen 5486, here figured (Pl. XXIV, fig. 6). On the other hand, the very similar suture-line of *B. oberholzeri*, Böhm (in Böhm and Heim, "Senonbild. d. Ö. Schweiz. Alp.," 'Abh. Schw. Pal. Ges.,' vol. xxxvi (1909), p. 52, pl. i, fig. 9), varies in just the opposite direction. The minute *B. n. sp.* in Jahn ('Beitr. z. Kenntn. d. Böhm. Kreide. Jb. K.K.R.A.,' vol. xlv [1895], p. 136, pl. viii, figs. 8 *a–c*) has a suture-line very similar to that of the Pondoland example, but the lobes are not clearly bifid.

†† *Loc. cit.* (1906), p. 65, pl. xv, fig. 3.

‡‡ *Loc. cit.* (1904), p. 90, pl. iii, fig. 24.

lane Hill. They probably belong to Woods' species in spite of the apparent absence of nodes, though this lack of ornament suggests affinity with *B. bailyi*, Woods (which apparently is rare, and characterised by a very distinct type of suture-line), or with other smooth species of *Baculites*.

The examples that Crick * records from the South Branch of the Manuan Creek, apparently related to *B. capensis*, Woods, are similarly poorly preserved and more or less indeterminable specimens.

Specimen No. 5484, containing at least twenty to thirty examples, has in addition to *B. capensis*, and forms close to *B. bailyi*, a number of more or less unidentifiable fragments that had best be included here. One example has the mouth border complete, but no initial whorls were discovered in this block, the reason being, perhaps, that this coarsely sandy, conglomeratic matrix (with pebbles of fossil wood) was not suitable for the preservation of so delicate a structure. The mode of life in the embryonic stage, also, possibly was different (planctonic ?) from the mud-boring existence of the adult shells.

Locality.—Umkwelane Hill. Coll. Dr. A. L. du Toit.

19. BACULITES cf. ASPERO-ANCEPS, Lasswitz.

(Pl. XXIV, figs. 4, 4 *a*.)

1852. *Baculites anceps*, Lamarck. Römer, Kreidebild. v. Texas, etc., p. 36, pl. ii, figs. 3 *b* and *c* only.

1904. *Baculites aspero-anceps*, Lasswitz. "Kreide-Amm. v. Texas," Geol. und Pal. Abh., vol. x, 4, p. 16, pl. iii (xv), figs. 1 *a* and *b*.

A small portion of a *Baculites* (No. 5480), 38 mm. in length and forming part of the body-chamber, differs from the many examples of *B. capensis* that occur in the same rock, merely in having the nodes closer, there being six in the length represented, as against half as many in Woods' species. The nodes are rounded, as in *B. capensis*, and the cross-section also, perhaps, resembles that of *B. asper*, Morton (in Römer), and of *B. capensis* more than it does that of *B. aspero-anceps*. The form here described probably is only a variety of *B. capensis*, comparable to the Texas form in the closer spacing of the nodes. It may be added that some of the examples included in *B. capensis* (*e. g.* No. 5490, and No. 5470) have the nodes closer than the (larger) Pondoland examples, and thus are transitional to the form here described.

Locality.—Umkwelane Hill. Coll. Dr. A. L. du Toit.

* *Loc. cit.* (1907), p. 240.

20. Baculites cf. brevicosta, Schlüter.

(Pl. XXIV, figs. 5, 5 *a*.)

1876. *Baculites brevicosta*, Schlüter. "Cephal. d. Ob. Deutsch. Kreide," Palaeontogr., vol. xxiv, p. 141, pl. xxxix, figs. 9 and 10.
[*Non* 1885. *Baculites brevicosta*, Schlüter, in Moberg, *loc. cit.*, p. 37, pl. iv, figs. 5 and 6.]

One example (No. 5461), showing nine nodes in a length of about 30 mm., apparently agrees with Schlüter's species, but it is not definitely identified with the species of the Emscher marls, since it probably only represents a variety of *B. capensis;* that is to say, its exact agreement with Schlüter's species* may be a case of heterochronous homoeomorphy. The suture-line agrees with that of *B. capensis*, and differs from that of *B. anceps* as figured by d'Orbigny† in having the two lateral lobes much narrower, and in having the siphonal portion of the ventral saddle smaller than the internal branch, an arrangement also seen in a specimen of *B. incurvatus*, Dujardin, in the writer's collection. The suture-line of *B. anceps*? figured in Schlüter‡ also has a comparatively large second lateral lobe. What Schlüter states to be observable in the type of *B. brevicosta*, namely, "saddles that are considerably broader than the lobes, and inferior lateral lobes that lie almost completely on the antisiphonal side," agrees with the characters of the suture-line of the Zululand form. *B. fairbanksi*, Anderson,§ though differing in ornament, has the same type of suture-line as *B. capensis* and *B.* cf. *brevicosta*, but with a more minutely frilled edge.

Locality.—Umkwelane Hill. Coll. Dr. A. L. du Toit.

21. Baculites sp. cf. sulcatus, Baily.

1906. *Baculites sulcatus*, Baily. Woods, "Cret. Fauna of Pondoland," Ann. S. Afr. Mus., vol. iv, part vii, No. 12, p. 341, pl. xliv, fig. 4.

One terminal fragment of a larger specimen (No. 5467), characterised by the absence of nodes, is striated like Baily's species, but the

* Wegner (in "Die Granulat. Kreide. d. Westl. Münsterland.," 'Zeit. Deutsch. Geol. Ges.,' vol. lvii (1905), pp. 207 and 228), who records this species from the zone of *Inoceramus cardissoides*, states that the nodes ("ribs") are crescent-shaped, whereas in the present example they are rounded like those of *B. capensis*.

† 'Pal. Franç. Ter. Crét.,' I (1840), p. 565, pl. cxxxix, fig. 7.

‡ *Loc. cit.* (1876), pl. xl, fig. 6.

§ *Loc. cit.*, p. 92, pl. vii, figs. 152 and 153, and pl. x, fig. 194.

folds are not so coarse as they are in Baily's original fig. 5 *c*, selected as type of the species by Woods. Also, whereas in Baily's holotype (No. 11373, Geol. Soc. Coll., British Museum), and still more so in the co-type, the folds are coarser on the dorsal than on the ventral sides, the reverse is noticeable in the present example, so that the latter may only be a variety of *B. capensis*, Woods, resembling some of the larger examples mentioned under the description of that species.

B. carinatus, Binkhorst,* has a somewhat similar ventral aspect, but in the specimen here described, the whorl section is elliptical and evenly rounded.

Locality.—Umkwelane Hill. Coll. Dr. A. L. du Toit.

22. Baculites bailyi, H. Woods.

1906. *Baculites bailyi*, Woods. "Cret. Fauna of Pondoland," Ann. S. Afr. Mus., vol. iv, part vii, No. 12, p. 341.

Three fragments (No. 5463) agree with Baily's original specimen† and have merely fine striation, not nodes, agreeing in this respect with *B. faujasi*, Lamarck, in Binkhorst ‡ = *B. vertebralis*, Montfort (?), and with the large forms, *B. ovatus*, Say, and *B. grandis*, Hall and Meek. *B. chicoensis* (Trask), Gabb,§ a number of specimens of which from Vancouver Island are in the British Museum, has only a slightly different suture-line and altogether seems very close.

B. syriacus, Conrad, according to a number of more or less badly-preserved specimens in the Egyptian Collection at the British Museum, referred to below (and associated with *B.* cf. *teres*, Forbes, and *B.* cf. *leopoliensis*, Nowak), probably also represents a similar smooth form of this group.

Locality.—Umkwelane Hill. Coll. Dr. A. L. du Toit.

* *Loc. cit.* (1861), Ceph., p. 43, pl. v *d*, fig. 2.

† 'Q. J. G. S.,' vol. xi (1855), pl. xi, fig. 5 *a*, *b* (non 5 *c*), B.M. (Geol. Soc. Coll.), No. 11372.

‡ *Loc. cit.* (1861), p. 40, pl. v *d*, fig. 1. The suture-line differs only in the width of the dorsal saddle.

§ *Loc. cit.* (vol. i), p. 80, pl. xvii, fig. 27 *a*, and pl. xiv, fig. 27 *b* ("commonest form, having few or no ribs"). Meek (*loc. cit.*, 1876, Bull. ii, p. 364), includes in the synonymy of *B. chicoensis*, Trask, his own *B. inornatus*, and Whiteaves ('Mesoz. Foss.,' 1903, p. 339) also includes in Trask's species Meek's *B. occidentalis*.

B. NAUTILOIDEA.

Gen. EUTREPHOCERAS, Hyatt.

23. Eutrephoceras aff. dekayi, Morton sp.

1907. *Nautilus dekayi* (Morton). Stuart-Weller, Report on Cret. Pal. of New Jersey, vol. iv (Pal. Ser.), Geol. Surv., N.J., p. 817, pl. c., figs. 2–5.

1910. *Nautilus dekayi* (Morton), Spengler. "Untersuch. ü. d. Südind. Kreideform. Pt. iv: Die Nautil. und Bel. d. Trichinopoly Distr.," Beitr. z. Pal. und Geol. Öst.-Ung., vol. xxiii, pt. iii, p. 137.

A small and poorly preserved specimen (No. 2751), of a little over 40 mm. in diameter, and of equal thickness, seems to agree with the typical figures cited above, and with specimens of this form from the Fort Pierre Shale, Black Hills, South Dakota, U.S.A., in the writer's collection. Since, however, the present example is somewhat crushed, so that the original shape of the whorl-section cannot accurately be determined, the specific identification must remain doubtful.

The position of the siphuncle (centran) corresponds with that shown in Fig. 4 of the reference given above, and not with that of fig. 1 *a* in Meek* (dorsocentran). Spengler gives the thickness as 90–100 per cent. (typically 92 per cent.), which agrees with that of the specimen here described. There does not appear to be an annular lobe.

Eutrephoceras ovoideus, G. C. Crick sp.,† probably an older (Cenomanian) species, has a more elevated, less depressed whorl section. *Nautilus* [*Cymatoceras*?] *occlusus*, G. C. Crick,‡ has a similar globose, though less depressed, whorl-shape, but the position of the siphuncle is centroventran, and there is an annular lobe—at least in the young. Since the Senonian also occurs at the North-West end of False Bay, it is impossible to state whether the six examples described by Crick are all of the same (Cenomanian) age, or even whether they are identical or co-generic, without breaking them up.

The Antarctic example of *Nautilus blanfordianus*, Kilian and Reboul,§

* "Report Invertebr. Cret. and Tert. Foss. Up. Missouri Country," in Hayden, 'U.S. Geol. Surv. of Territ.,' vol. ix (1876), p. 496, pl. xxvii.

† *Loc. cit.* (1907), p. 222, B.M., No. C18253–6.

‡ *Ibid.*, p. 224, B.M., No. C18257–62.

§ "Les Céph. Néocrét. d. Îles Seymour et Snow Hill," 'Wiss. Ergeb. Schwed. Südpol. Exped.,' vol. iii, pt. vi (1909), p. 8, pl. i, figs. 1 and 2.

represents a very similar form of *Eutrephoceras* to the specimen here described, with the thickness about equal to the diameter, but the siphuncle is ventrocentran in the Antarctic form, as it is in the far less depressed *N. huxleyanus*, Blanford.

Locality.—Umfolozi Valley, East of Railway. Coll. J. L. Illingworth.

24. Eutrephoceras *cf.* sublaevigatum (d'Orbigny) var. indica (Spengler).

1861. *Nautilus bouchardianus*, d'Orbigny. Blanford, Cret. Fauna S. India (Pal. Indica), vol. i, "Cephalop.," pl. v, fig. 3.

1910. *Nautilus sublaevigatus* var. *indica*, Spengler. "Untersuch. ü. d. Süd-Ind. Kreideform. Pt. iv. Die Nautil. und Bel. d. Trichinopoly Distr.," Beitr. z. Pal. und Geol. Öst-Ung., vol. xxiii, pt. iii, p. 137.

A nearly complete but slightly weathered example of a *Nautilus* (No. 5509) agrees well in proportions with the large specimen figured by Woods,* and at a diameter of 150 mm. has a thickness of 110–115 mm. The sides and ventral area, however, are more flattened (weathered?), giving the whorl a more quadrate shape. The last half whorl of the specimen represents the body-chamber, with indications of a mouth-border at the end. Several specimens of *Baculites* are embedded in the matrix of this body-chamber.

Since the specimen was not broken up to reveal position of the siphuncle, presence of an annular lobe, etc., the identification with the Indian form of *N. sublaevigatus*, with which Woods also had compared his Pondoland example, must remain doubtful. It is based on similarity of whorl-shape and dimensions and general agreement with Blanford's fig. 3.

The probably Cenomanian *Eutrephoceras ovoideum*, G. C. Crick sp.,† has a more elevated whorl-section, and *Nautilus* [*Cymatoceras*?] *occlusus*, G. C. Crick, is too inflated in the umbilical region.

Some of the *Nautilus* (*Eutrephoceras*) sp., described by Crick‡ from the South Branch of the Manuan Creek, Zululand, may belong to the present Senonian species.

Locality—Umkwelane Hill, Umfolozi, Zululand. Coll. Dr. A. L. du Toit.

* *Loc. cit.* (1906), p. 330, text-fig. 1 on p. 331.

† *Loc. cit.* (1907), p. 222.

‡ *Loc. cit.* (1907), p. 245, B.M., Nos. C18292–5.

Gen. CYMATOCERAS, Hyatt.

25. Cymatoceras? sp. juv. cf. valudayurense, Blanford sp.

1861. *Nautilus valudayurensis*, Blanford. Cret. Fauna S. India (Pal. Indica), vol. i, "Cephalop.," p. 23, pl. xii, figs. 2–3.
1866. *Nautilus valudayurensis*, Stoliczka, *ibid.*, p. 206.

A small and fragmentary specimen (No. 5469), consisting of the casts of four camerae in a very good state of preservation, agrees with Blanford's figures, especially in the outline of the sectional view (fig. 3), in position of the siphuncle (centrodorsan), and the presence of a small annular lobe. The decussate ornament figured in 2 *b* also is well shown in the dorsal impression, but on the outer whorl only striae of growth are visible, not the coarse folds typical of *Cymatoceras*. On the other hand, the presence of the linguiform annular lobe shows the specimen to be distinct from *Eutrephoceras*,* some examples of which (e. g. *E. dekayi* (Morton), var. *montanaense*, Meek†) agree with it in whorl-section. Of the various forms included by Spengler‡ in *Nautilus* [*Cymatoceras*] aff. *atlas*, Whiteaves, the small ammonite figured by Blanford§ somewhat resembles the fragment here described, but the siphuncle is ventrocentran in the Indian specimen, not centrodorsan.

The small *Nautilus* sp. described by Crick‖ has a similar septal surface, with annular lobe, but a more depressed section, and probably is of Albian age, as also is *Cymatoceras manuanense*, Crick sp.¶ The large examples of this species have no annular lobe, but agree in section and position of siphuncle.

Locality.—Umkwelane Hill, Umfolozi, Zululand. Coll. Dr. A. L. du Toit.

Observations on the Umkwelane Hill Fauna.

To the Cephalopoda from Umkwelane Hill, described in the foregoing pages, must be added three Ammonoids recorded by Etheridge, namely:

Placenticeras kaffrarium, Etheridge.
,, *umkwelanense*, Etheridge.
Diplomoceras? cf. *large-sulcatum*, Forbes sp.

* Hyatt, "Phylogeny of an Acquired Characteristic," 'Proc. Am. Philos. Soc.,' xxxii, No. 143, 1894, appendix, p. 555.

† *Loc. cit.* (1876), p. 498, pl. xxvii, figs. 2–2 *f*.

‡ *Loc. cit.* (1910), p. 135.

§ *Loc. cit.* (1861), pl. viii, fig. 4.

‖ *Loc. cit.* (1907), p. 248, B.M., No. C18310.

¶ *Ibid.*, p. 243, pl. xv, fig. 6, B.M., Nos. C18282–5.

Further, the typical—

Mortoniceras umkwelanense, Crick,

so that up to the present twenty-nine species and varieties have been described from this locality.* The form figured by Etheridge as "*Creniceras* (?) *sp. ind.*" is not included, since its systematic position is quite uncertain, and since it may not even be a cephalopod.

Woods and Newton considered the Umkwelane Hill fauna to be of the same age (Campanian) as that of Pondoland. The occurrence, at Umkwelane Hill, of a form (*Mortoniceras woodsi*, nov.) that is very close to *M. delawarense*, confirms the presence of the Campanian, and there certainly is no indication of any Cenomanian or "Vraconnian" admixture in this fauna, as suggested by Lemoine.† On the other hand, the Maestrichtian, or part of it, may also be represented in South Africa. *Parapachydiscus* of the *colligatus* type are quoted both from Campanian and Maestrichtian‡ deposits; and *Placenticeras umkwelanense*, compared by Etheridge with *P. placenta*, also the two Nostoceratids, recall Maestrichtian forms. According to Woods, *Pseudophyllites indra* occurs in the basement bed of the Pondoland deposit; and Haug calls the "*Anisoceras*" and *Trigonoarca* beds of the Valudayur group (with *Pseudophyllites indra*) Maestrichtian, but in the writer's opinion, the many large *Mortoniceras*, characteristic of South Africa, are pre-Maestrichtian.

The occurrence, in the Pondoland Collections, of these *Mortoniceras* in the same blocks with *Hauericeras gardeni* and with *Pseudoschloenbachia*, makes it probable that they are, indeed, Upper Senonian. De Grossouvre's contention that the Pondoland deposits are of Lower Senonian age and somewhere near the limit of the Coniacian and Santonian divisions has been questioned by Woods,§ who stated that "the probability that one zone only is represented is supported by the observations made by the Survey that most of the species range throughout the deposit, as well as by the small thickness of that deposit."

* Newton (*loc. cit.*, p. 96) recorded the occurrence of a *Baculites*, closely resembling *B. bailyi*, Woods, in the matrix of an Umkwelane Hill specimen.

† 'Études Géol. dans le Nord de Madagascar,' Paris, 1906, p. 396. On this page Lemoine puts part of the Umkwelane Hill beds (with *Mortoniceras* and "*Anisoceras*") as equivalent to the Utatur beds of Southern India, but on p. 403 he classes the fauna, described by Etheridge, as Senonian, whereas in the table on p. 405 the former beds (with *Mortoniceras* and "*Anisoceras*") are, perhaps through a slip, included in the Turonian.

‡ The specimen here described as *P. n. sp.* aff. *colligatus* shows very good agreement with a typical French example (B.M., No. C524), except that it is thicker.

§ *Loc. cit.* (1906), p. 346.

At Umkwelane Hill, as in Pondoland, it is chiefly the resemblance of the *Mortoniceras* to *M. texanum*, and of *Pseudoschloenbachia* to Grossouvre's Coniacian-Santonian forms that suggests the presence of pre-Campanian horizons.

The additional evidence, however, is not very satisfactory so far as exact dating of the beds within the Senonian is concerned; and it is hardly safe, from the evidence available, to assume the complete absence of pre-Campanian horizons at Umkwelane Hill. *Placenticeras subkaffrarium*, nov., is close to *Pl. tamulicum*, Kossmat, which occurs in the Upper Trichinopoly group of India; and at the Manuan Creek, this new form, or a close ally, is associated with *Kossmaticeras (Madrasites) bhavani*, Stoliczka sp., also common to the Upper Trichinopoly and the Aryalur groups. Now the former group includes *Peroniceras dravidicum*, Kossmat sp., which is here described from the junction of the Manuan and Umsinene Rivers, whereas two other forms of *Peroniceras* (*P.* cf. *czörnigi*, Redtenbacher sp., and *P.* cf. *rousseauxi*, Grossouvre) were included in the collection described by the late G. C. Crick. The presence of the Coniacian in Zululand is thus established.

Again, the new genus *Diaziceras*, the type-specimen of which is associated in the same block with *Bostrychoceras ? sp. ind.*, a form that is comparable with certain Upper Senonian types of the Hokkaido and of California, is here considered to be related to *Pseudoschloenbachia papillata* from Pondoland, but in suture-line the new genus is very close to *Lenticeras andii*, Gabb sp., or *L. baltai*, Lisson, whereas "*Barroisiceras*" *desmoulinsi*, Grossouvre sp., resembles it very much in external characters. Both these genera are of Lower Senonian age; *Barroisiceras* occurs associated with *Peroniceras* in Madagascar and the Cameroons; *Lenticeras* is associated with *Mortoniceras texanum* in South America.

It may also be pointed out that the new collection of Pondoland fossils belonging to the Durban Museum, and referred to in the introductory part of this paper, contains "*Puzosia*" *sugata*, Forbes sp., and an Ammonite resembling the Madagascar example of "*B. haberfellneri* (Hauer)," figured by Boule, Lemoine and Thévenin.* This new form may, perhaps, be more nearly related to certain Upper Chico types, e.g. "*Schloenbachia*" *chicoensis* (Trask), Anderson,† though similar "*Barroisiceras*" also occur in the Lower Chico formation, but are not satisfactorily separated from numerous forms that may be true *Prionocyclus*. "*Puzosia*" *sugata*, also, is recorded from the Lower Chico

* *Loc. cit.* (1907), ii, p. 43, pl. xi, fig. 3 only.

† *Loc. cit.* (1902), p. 116, pl. ii, figs. 23–25.

formation*; but in India it occurs in the Lower Aryalur and Upper Trichinopoly groups, and Haug† has it, both in the Santonian and in the Maestrichtian, on the same page.

The difficulties of exact correlation were probably felt by Kilian and Reboul,‡ who put the beds of Snow Hill and Seymour Islands, that both contain *Kossmaticeras* (*Madrasites*) *bhavani*, into the Senonian s.l. (= Santonian to Maestrichtian), placing the lower horizon as equivalent to the Indian Upper Trichinopoly group, whereas the upper beds show close affinity, not only with the Aryalur and Valudayur groups, but also with the Campanian or Maestrichtian deposits of Southern Patagonia. The fact that *Placenticeras*, similar to the Zululand forms, occur in the Maestrichtian Fort Pierre Shale of America, perhaps, is in favour of the attribution of the fauna here discussed, and of Pondoland, to this upper horizon of Antarctica; and it may be added that the two forms here described from the north-west shore of False Bay (*Mortoniceras vanuxemi*, Morton sp., and *Bostrychoceras?* sp.) also are of Campanian age; further, that the isolated specimen of *Peroniceras* cf. *dravidicum*, representing a cast in limonite, after pyrites(?), differs in mode of preservation from the Ammonites of the Umkwelane Hill fauna as from the two forms of *Peroniceras* described by Crick. If not all, at least the great majority of the forms of the Umkwelane Hill and Pondoland Ammonite faunas probably are of Campanian (and Maestrichtian?) age, and in his phylogenetic interpretation of the genera *Pseudoschloenbachia* and *Diaziceras*, the writer assumed their Upper Senonian age. But the occurrence, at about the limit between the Coniacian and Santonian—at which level the Pondoland fauna had been placed by Grossouvre—and associated with *Mortoniceras texanum*, of forms like *Lenticeras*, *Barroisiceras* § and what the writer considers to be *Gauthiericeras* developments (*bertrandi-fournieri* group), affords the most striking

* Kilian and Reboul (*loc. cit.*, p. 60) quote it as Upper Chico, but Anderson (pp. 27 and 98) distinctly characterises it as a Lower Chico species.

† *Loc. cit.*, II, ii, p. 1342.

‡ Table on p. 58, *loc. cit.*, also p. 59. In this Antarctic fauna, also, the great majority of forms are Upper Senonian. The little-known genera *Grahamites* and *Seymourites* show a very striking resemblance to certain Canadian Fort Pierre forms in the British Museum, including *A. barnstoni*, Meek ('Saskatchewan Exploring Expedition: Geolog. Report,' H. Y. Hind, Toronto, 1859, Chapter XIX (by F. B. Meek), p. 197, pl. ii, figs. 1–3).

§ E.g. *B. dentato-carinatum*, Roemer (Hill), a form very near to "*Schloenbachia*" *siskiyouensis*, Anderson (Lasswitz, p. 29, thought them identical), which perhaps resembles the Pondoland form, referred to above, as much as does the Upper Chico "*Schl.*" *chicoensis* (Trask) Anderson.

parallel to the *Mortoniceras-Diaziceras-Pseudoschloenbachia* assemblage, here recorded from Umkwelane Hill.

It may be added here that whereas, in East Africa, the succession from the Bathonian up to the Aptian* is represented by generally ammonitiferous deposits, in Zululand, as probably also in Mozambique,† there is a fairly complete succession from the Aptian to the Maestrichtian, with the exception of the Turonian, the presence of which in Madagascar also has not been clearly demonstrated. It is of interest to note that the Coniacian *Peroniceras*, mentioned above, and which is almost indistinguishable from a Bohemian *P. subtricarinatum*, d'Orbigny sp.,‡ is closely comparable with a type that occurs in India and Madagascar and has also been recorded from the Cameroons. Marine connection across Africa certainly did not exist, and the writer thinks the evidence favours Lemoine's§ contention that the communication between the Indian and Mediterranean seas did not, as Kossmat thought, take place *viâ* the south of the African continent. The genus *Peroniceras* also occurs in Tunis and in the Egyptian-Syrian Coniacian, and the Turonian faunas (with *Fagesia* and *Neoptychites*) of Tunis and India are closely allied. Unworked Nigerian collections with *Pseudotissotia*, *Vascoceras*, etc. (Falconer, Kitson, and Temple Colls., British Museum), show that during the Turonian (as during the Albian) there was connection between the Cameroons Bay and the great sea that covered the whole of the Sahara‖ and extended across to India, but no further (Turonian) extensions down the east or west coasts of Africa, can be traced by ammonitiferous deposits, though a different facies may represent the Turonian both in Angola and in Madagascar.¶ *Peroniceras dravidicum*, thus, probably came to the Cameroons by way of Tunis, and not *viâ* South Africa. The distribution of this form, therefore, is not

* See Zwierzycki, "Ceph. Faun. d. Tendaguru-Sch. i. Deutsch-Ostafrika," *loc. cit.* (1914), pp. 90–91; also Spath, "Jurass. Amm. fr. E. Africa," 'Geol. Mag.,' vol. lvii (1920), pp. 311–20, 351–62.

† The Dipoloceratidae of the Albian are poorly represented there, and "*Mortoniceras* cfr. *candollei*" in Choffat ('Conducia,' 1903, p. 24, pl. vi, figs. 3 and 4) cannot be definitely identified as a form of the Upper Albian *candollianus* group.

‡ B.M. No. 88991, Coll. Dr. Fritsch.

§ 'Ét. Géol. Nord de Madagascar,' Paris, 1906, p. 397.

‖ A collection of Turonian Ammonites from Sinai (T. Barron Coll.), described in an unpublished paper by Crick, contains *Hoplitoides*? and *Vascoceras*.

¶ According to Kilian and Reboul (*loc. cit.*, 1909, p. 64), this Turonian Mediterranean, extending from Brazil to India, did not communicate directly with Madagascar.

of great significance, and, at any rate, there is no record from the West Coast of Africa, of an ammonite indicative of the great Campanian transgression which left the deposits of the Indo-Pacific type (with *Kossmaticeras* and *Lytoceratidae*), and of the Atlantic type (with *Mortoniceras* and *Placenticeras*) discussed by Kilian and Reboul.*

Of the twenty-nine species of Cephalopoda of the Umkwelane Hill fauna, only one Ammonite (*Pseudoschloenbachia umbulazi*) is identical with a Pondoland species, in addition to a number of uncoiled and straight forms (*Bostrychoceras ?*, *Diplomoceras ?*, *Baculites*), and to a *Nautilus*. The assemblage of these genera suggests close affinity of this South African fauna with that of the Egyptian Maestrichtian †; but the place of *Pseudoschloenbachia umbulazi*, there, is taken by a new species (doubtfully classed as a Cenomanian *Schloenbachia* by Blanckenhorn [in Coll.]), whereas the plentiful *Eutrephoceras desertorum*, Zittel sp., replaces the form here described as *E.* aff. *dekayi*, Morton sp. The abundance of *Baculites* and the frequent occurrence of uncoiled forms, in the Egyptian as well as the South African deposits, are further points of similarity; and it may be noted here that *Mortoniceras* of the *delawarense* group are common to Tunis and Zululand, and that *Parapachydiscus colligatus*, also, has been recorded from Tunis as well as from Madagascar.

The two genera *Mortoniceras* and *Parapachydiscus*, of course, are other elements common to the two faunas, even if the species are different, and it may be recalled here that Newton‡ found "very few of the shells [from Manuan Creek] to occur in contiguous areas, such as . . . Umkwelane Hill and . . . Pondoland. . . ." The great abundance of large forms of *Mortoniceras*, with the equally frequent occurrence of *Hauericeras gardeni*, and the presence of the (less common) *Pseudoschloenbachia*, form the characteristic feature of the Pondoland deposits, and distinguish them from the Egyptian and Madagascar faunas. In the "new collection of Natal fossils, at the Natural History Museum, far surpassing all collections hitherto made" (Kossmat §), out of a total of 105 specimens, 43 are *Mortoniceras*. But it is significant that *Hauericeras gardeni*, a typical Indo-

* *Loc. cit.* (1909), pp. 64–5. Through the kindness of Mr. Beeby Thompson, of Northampton, the writer has lately (February, 1921), been able to study a new collection from Angola, including Upper Senonian Ammonoids (*Didymoceras*).

† In Haug (*loc. cit.*, p. 1335), who considers the presence of the Campanian to be doubtful, so that the great Upper Senonian transgression may here have been of a slightly later date.

‡ *Loc. cit.* (1909), p. 95.

§ 'Rec. Geol. Surv. India,' vol. xxviii (1895), pt. ii, p. 43. See also Newton, *loc. cit.* (1909), p. 14.

Pacific element, of which the latter collection includes no fewer than thirty-seven specimens, is unrepresented at Umkwelane Hill, as are the genera *Gaudryceras, Tetragonites* and *Pseudophyllites*, the last represented in the new collection by three specimens, one of which reaches the diameter of 290 mm.

The gigantic *Parapuzosia* and the *Placenticeras*, also, are represented only in the Umkwelane Hill fauna, and though occurring in Madagascar, are not known from Pondoland. The Zululand locality also has the unique *Diaziceras* as a strictly local type, whereas in Pondoland *Eulophoceras* and its close ally *Sphenisocoeras* form special developments, not occurring elsewhere.

It is clear that this indicates a difference of facies, the stenothermal *Lytoceratidae* being dependent on deeper water or warm currents. Lithologically the difference is indicated by the absence of glauconite in Zululand; and what changes of facies may be observed in a distance equal to that separating the Pondoland Umzamba beds from Umkwelane Hill, is seen when comparing the deposits of the warm coralline Gosau Sea with the contemporaneous beds left by the colder Chalk Sea. These *Lytoceratidae* are absent also in Egypt and Baluchistan, but occur in Madagascar and Southern India, and, as regards Pondoland, their distribution cannot be said to support the view put forward by Grossouvre (and not accepted by Woods), that there was at least as close a relationship to the fauna of the Chalk of Europe as to that of Southern India. The fact that *Mortoniceras*, which forms one of the most important elements of the South African faunas, is absent in India, of course constitutes a striking difference, and might unduly encourage comparison with corresponding European assemblages such as those of Galicia or Poland, where *Hauericeras gardeni* and *Kossmaticeras* (?), two Indo-Pacific elements, occur. Taking the South African fauna as a whole, however, its affinity with the Indo-Pacific fauna is undeniable, and, as has been mentioned before, the "Atlantic" type of deposit (with *Mortoniceras* and *Placenticeras*) found in Zululand, and the Indo-Pacific type (with *Lytoceratidae* and *Kossmaticeras*) occurring in Pondoland,* are connected by the presence in both faunas of *Pseudoschloenbachia*, probably an active swimmer, and of benthonic crawlers (*Diplomoceras, Bostrychoceras*) and mud-boring *Baculites*.

Of particular interest, perhaps, are the two turricones of the

* It is interesting to note that the additional Ammonites from Pondoland, lately described by Dr. van Hoepen, and, with one or two exceptions, the fauna sent by the Durban Museum, consist of such "Indo-Pacific" types, unknown at Umkwelane Hill.

Umkwelane Hill fauna, partly because they represent benthonic types of limited powers of migration, compared with the oxycone developments of the Upper Senonian, that might be thought to have been active swimmers, but are often curiously restricted, just as other marine organisms often may have a limited horizontal distribution.* Their nearest allies, hitherto described, are European, Japanese and North American forms, but in an unworked Egyptian Collection in the British Museum there are, besides *Bostrychoceras*, which also occurs in Tunis, Baluchistan, India and Madagascar, fragmentary Nostoceratids, comparable with the Zululand species and with Fort Pierre types from the United States and from Canada.† These forms again point to a direct connection with North Africa, as did *Mortoniceras*, and it appears probable that ever since the breaking up of Suess's Gondwanaland, or at least from the time of the Aptian transgression, the Zululand Cretaceous Sea was open not only to Antarctic-Pacific elements coming from south-west, but was in direct communication, through the Mozambique Channel, with the sea to the north‡ that led to the Mediterranean on the one hand and to India on the other.

Boule, Lemoine and Thévenin§ stated that there was a gradually diminishing number of forms common to the North African and the Madagascar faunas, as the beds became higher in the Cretaceous succession; and they noted the absence of *Tissotia*, which constitutes an important element in the North African fauna. Such a relation, perhaps, is also to be observed in Zululand; but the figures, at any rate, prove little, considering the differences in the facies of two neighbouring areas such as, *e.g.*, Pondoland and Zululand. In the much more completely known Tunisian fauna, both the "Atlantic" and the "Indo-Pacific" types (though the latter without *Kossmaticeras*) are represented. If, however, the Umkwelane Hill fauna be compared with the neritic Egyptian or European faunas and the Pondoland fauna with a corresponding bathyal|| assemblage of North

* Mr. S. S. Buckman ("Jurassic Chronology: I, Lias," Suppl. I, 'Q. J. G. S., vol. lxxvi, pt. i, 1920, pp. 66–67) considers that analogy with modern organisms does not hold, but his remarks are unconvincing, as a study of the distribution, and dependence on facies, of the two fundamental stocks of Ammonites (*Lytoceratidæ* and *Phylloceratidæ*) will show.

† *Exiteloceras* cf. *angulatum* (Meek), *Didymoceras ?*, sp. (*cf. Heteroceras polyplocum*, Römer sp. (pars), in Schlüter, 1872, p. 112, pl. xxxiv, fig. 1 only). Comparable forms have also been discovered in Angola (see footnote on p. 269).

‡ In Krenkel's sense ("Unt. Kr. v. D.-Ostafr.," 'Beitr. Pal. Öst.-Ung.,' vol. xxiii, 1910, p. 249).

§ *Loc. cit.* (1907), p. 71.

|| The term "*bathyal*" is misleading, for *Lytoceratidae, e. g.*, may occasionally occur in comparatively shallow-water deposits (*jurense*-zone).

Africa or Europe, the agreement may be found to be less close than it was during Albian times.

Uhlig* thought that the aspect of the [Jurassic and Lower Cretaceous] fauna as a whole justified the establishment of an Ethiopian province by Neumayr, later regarded by Dacqué and Krenkel as a sub-area of the Indian Province. In the Upper Cretaceous, this "Ethiopian Province" had lost its individuality, if it ever formed a separate province; for, *e.g.*, Haug points to the presence of the peculiar genus *Bouleiceras* in Madagascar as possibly indicating a separate zoological province, but the writer has found a specimen of *B. nitescens*, Thévenin, in a Domerian-Toarcian collection from Baluchistan.† At any rate, in the Upper Cretaceous, the Indo-Malgascan fauna shows the closest relations with those of the Pacific and Antarctic provinces; and the most characteristic element of this vast "Indo-Pacific" province is the genus *Kossmaticeras*, as pointed out by Haug.‡ Through a slip, this author also stated§ that *Kossmaticeras* was not known either in Madagascar or in South Africa, whereas on pp. 1344 and 1355 he quotes it from both localities.

Under the description of *Kossmaticeras* (*Madrasites*) *bhavani*, Stoliczka sp., in the Manuan Creek fauna, the writer has referred to various South African forms, and other hitherto unrecorded species of *Kossmaticeras* and allied genera from New Zealand, and the presence of this genus in South Africa shows the fauna to belong to this great "Indo-Pacific Province"|| in spite of the number of "Atlantic" types introduced from the North *viâ* Egypt.

* "Marine Reiche d. Jura and d. Unterkr.," 'Mitt. Geol. Ges. Wien," iv (1911), 3, p. 406.

† British Museum (Geol. Society Coll.), from Valley of Kelat, Baluchistan, together with *Phylloceras*, *Rhacophyllites*, *Lytoceras*, *Fuciniceras*, *Protogrammoceras*, *Dactylioceras*, etc.

‡ *Loc. cit.*, vol. ii, 2, p. 1369.

§ *Ibid.*, p. 1369.

|| The communication, to the West, with Graham Land, Southern Patagonia and Chili, is perhaps even more certain, and in all these areas, as pointed out below (p. 307), the deposits consist largely of glauconitic, calcareous sandstones, contain the same fossil assemblages, and apparently pass uninterruptedly into the lower Eocene.

III. THE MANUAN CREEK FAUNA.

Description of Species.

A. ALBIAN.

1. AMMONOIDEA.

Family: PHYLLOCERATIDÆ.

Gen. PHYLLOCERAS, Suess.

1. Phylloceras velledae, Michelin sp.

1906. Boule, Lemoine & Thévenin: "Pal. de Madagascar, III, Céph. d. Diego-Suarez," Ann. de Pal., vol. i, fasc. 4, p. 7, pl. i, fig. 11.

1907. Crick. Third Report, p. 236 (*Phylloceras* sp.), B.M., No. C18264.

This well-known form is represented by a fragment (No. 4992) completely septate, of a large example, agreeing both with the Zululand and Madagascar specimens and with d'Orbigny's* and Pictet's† European types, in whorl-shape, ornamentation and suture-line. At a diameter of 130 mm. the thickness is 47 mm., or 36 per cent. of the diameter, which agrees with that of d'Orbigny's type. The fragment, being nearly half of the Ammonite, shows the inner whorls in section, and at a diameter of 54 mm. the thickness still is 36 per cent., whereas the example figured by Crick as *P. velledae*, Stoliczka (*non* Michelin?), has very flat sides, considerably more compressed than Stoliczka's large example.§ Crick's figured specimen, which also shows striation only on the periphery, though the sides are weathered, probably also is of later (*i. e.* Cenomanian) age, and may be closer to the variety figured by Boule, Lemoine and Thévenin in fig. 10.|| On the other hand, the *Phylloceras* sp., from the South Branch of the Manuan Creek, recorded by Crick, is identical with the form here described.

Locality.—Middle Branch, Manuan Creek. Coll. W. J. Wybergh.

* *Loc. cit.* (1840), p. 280, pl. lxxxii.

† In Pictet and Roux, *loc. cit.* (1847), p. 30, pl. ii, fig. 1.

‡ *Loc. cit.* (Third Report, 1907), p. 166, pl. x, fig. 11 (B.M., No. C18137).

§ *Loc. cit.* (1865), p. 116, pl. lix, fig. 2.

|| Of pl. i. This is dated, in explanation of plate, as "Cénomanien supérieur," but in the text (p. 8) the horizon is given as "Sénonien inférieur."

FAMILY: DESMOCERATIDÆ.

GEN. PUZOSIA, Bayle.

2. PUZOSIA cf. BHIMA, Stoliczka sp.

Compare:

1865. *Amm. bhima*, Stoliczka. Cret. S. Ind. vol. i, p. 137, pl. lxix, fig. 2.

1898. *Puzosia bhima*, Kossmat. Unters. S. Ind. Kreidef. pt. iii, Beitr. Pal. und Geol. Öst.-Ung., etc., vol. xi, p. 119.

1907. *Puzosia pinguis*, Crick. Third Report. Geol. Surv. Nat. and Zulul., p. 218.

A fragmentary example (No. 4907), originally of about 200 mm. diameter, but still septate at the end, shows close agreement with Stoliczka's large specimen and with the very similar False Bay form. The dimensions probably were:

Height of the last whorl	.	46 per cent. of the diameter
Thickness ,, ,,	.	39 ,, ,, ,,
Umbilicus . .	.	25 ,, ,, ,,

On the test, which is 1·5 mm. in thickness, the varices are not shown, but there is a labial ridge across the periphery, corresponding with a sulcus on the cast, though this sulcus extends across the sides as well. In addition to these ridges, which form a less acute sinus on the venter than they do in *P. bhima* or *P. pinguis*, there is faint and irregular striation on the test. The presumably Cenomanian *P. subtilis*, Crick,* has very similar ornament, but is more compressed (thickness = 31 per cent.) and more involute (umbilicus = 20 per cent.). *P. pinguis*, Crick, with a thickness of 36 per cent., appears to be merely an inflated form of the *subtilis* type; but since it may be of Cenomanian age, and since the suture-line cannot be compared, its exact relations to *P. bhima* must remain somewhat uncertain. The larger fragment in the British Museum (No. C18243) is extremely close to the specimen here described, and differs, apart from slightly varying proportions, only in having more acutely linguiform ridges on the periphery—a character in which it is nearer to the Indian species than to the specimen here described.

P. insculpta, Kossmat† is more compressed, but the large examples

* *Loc. cit.* (Third Report), p. 217, pl. xiv, figs. 5, 5 *a*.

† *Loc. cit.* (1898), p. 120, pl. xviii, fig. 5.

from Madagascar figured by Boule, Lemoine and Thévenin* are very close to the present specimen. On the other hand, the writer would doubt whether Sharpe's *P. octosulcata,*† included by Pervinquière ‡ in *P. mayoriana,* d'Orbigny sp., is as close to *P. bhima* as Kossmat thought. *P. compacta,* Crick,§ from the Middle Tributary of the Manuan Creek, and probably of the same age as the form here described, *i. e.* Upper Albian, may be the young of a form of the *planulata* group, comparable with *P. octosulcata. P. concinna,* Crick,|| from the same locality, was stated to come nearest *P. bhima,* but has only five constrictions, distinct costation at a small size, and a far less conspicuous forward sweep of the sulci, so that this species also has closer relations with the *planulata* group than with the *insculpta-bhima* group.

Locality.—Middle Branch, Manuan Creek. Coll. W. J. Wybergh.

Gen. UHLIGELLA, Jacob.

3. Uhligella? sp. nov. aff. stoliczkai, Kossmat sp.

Compare:

1865. *Amm. beudanti,* Stoliczka. Cret. S. Ind., vol. i, p. 142, pl. lxxi, figs. 2–4, *non* fig. 1.

1898. *Puzosia stoliczkai,* Kossmat. "Untersuch. S. Ind. Kreidef.," pt. iii, Beitr. Pal. und Geol. Öst.-Ung., xi, 3, p. 119, pl. xviii, fig. 6.

1907. *Puzosia stoliczkai;* Crick. Third Report Geol. Surv. Nat. and Zulul., p. 216.

1908. *Puzosia (?) stoliczkai;* Jacob. "Et. Pal. and Strat. Part. Moy. Ter. Crét.," Trav. Lab. Géol. Univ. Grenoble, vol. viii, p. 350.

The specimen (No. 4902) that is referred to this species is somewhat fragmentary, but permits of the dimensions being measured at the following two diameters:

Diameter	120 mm.	54 mm.
Height of last whorl . .	46 per cent.	41 per cent.
Thickness ,, ,, . .	30 ,,	30 ,,
Umbilicus	24 ,,	30 ,,

* *Loc. cit.,* I (1906), p. 19, pl. iii, figs. 2–4. These authors state that *P. stoliczkai* has a notably wider umbilicus than *P. insculpta,* whereas Kossmat's figures are 22 per cent. and 25 per cent. respectively for the umbilical widths in these two species.

† *Loc. cit.* (1856), p. 42, pl. xix, fig. 3.

‡ *Loc. cit.* (1907), p. 157; but see the writer's "Cret. Amm. from Angola, to be published shortly.

§ *Loc. cit.* (1907), p. 246, pl. xv, fig. 7 (B.M., No. C18307).

|| *Loc. cit.* (1907), p. 245.

These figures indicate that with increase in size, the umbilicus becomes narrower, whereas the Indian examples appear to be more involute in the young. The inner whorls of the present example are smooth, as are Stoliczka's specimens; but on the periphery of the outer whorl costation appears, between the numerous sulci, as in *P. compressa*, Kossmat.* A further point of difference is the slight flattening of the sides in the Zululand example, combined with a wider venter, making the whorl-section more rectangular than that of Stoliczka's larger example (fig. 3 *a*), *i. e.* more like that of his fig. 2 *a*. The umbilical slope, also, is inclined, not perpendicular, or even overhanging, as in Stoliczka's species, and agrees with that of Crick's specimen.

The constrictions, however, are very similar to those of Kossmat's species, and it may be recalled that Crick already had described his example as being slightly more compressed than Stoliczka's fig. 3 *a*. The False Bay example also has, at a diameter of 82 mm., practically the same dimensions as the larger specimen here described.†

Etheridge‡ figured a very large "*Desmoceras* sp." from the Albian of the Umsinene River, in the neighbourhood of the Manuan Creek, and thought it possibly allied to the "Ootatur form of *D. beudanti* (Brongniart)" = *P. stoliczkai*, Kossmat, 1898. The presence of costation might suggest that it is a large example of the form here described, in which ribbing appears near the end; but the constrictions appear to be quite different, and it is probable that Etheridge's form is related to the forms of the *planulata*-group, with straight constrictions, found in Angola.

Puzosia of the *insculpta-bhima* group, referred to above, have a different course of the constrictions, and the costate *planulata* group is too evolute. The reference of the present form to *Uhligella*, after Jacob, the author of the genus, appears somewhat doubtful.

Locality.—Middle Branch, Manuan Creek. Coll. W. J. Wybergh.

* = *A. durga*, Stoliczka, *non* Forbes, *loc. cit.*, pl. lxxi, fig. 7.

† A specimen, not noticed by Crick in his paper, but labelled by him *? Beudanticeras beudanti*, Brongniart sp. (B.M., No. C18303), is identical with the form here described, and *Hauericeras* sp. (recorded on p. 243), together with a second *Hauericeras ?* sp., not mentioned in the paper (B.M., Nos. C18276–77), probably also belong here.

‡ "Cret. Foss. Natal," II, 'Third Report Geol. Surv. Nat. and Zulul.,' 1907, p. 88, pl. vi.

FAMILY: DIPOLOCERATIDÆ.

GEN. DIPOLOCERAS, Hyatt.

4. DIPOLOCERAS CRISTATUM, Deluc sp.

(Pl. XXV, fig. 2; Pl. XXVI, fig. 6.)

1822. *Amm. cristatus*, Deluc in Brongniart. Environs de Paris, pp. 95 and 395, pl. vii, fig. 9.
1907. *Mortoniceras* (?) *cristatum* (Deluc), Pervinquière. Et. d. Pal. Tunis. Céph. Ter. Second, p. 239.
1908. *Mortoniceras* (?) *cristatum* (Deluc), Jacob. "Et. Pal. and Strat Part. Moy. Ter. Crét.," Trav. Lab. Géol. Univ. Grenoble, vol. viii, pp. 326 and 384.

This well-known species is represented in the collection by two examples of the following dimensions:

	No. 2728.	No. 2727.
Diameter	144 mm.	65 mm.
Height of last whorl . .	35 per cent.	33 per cent.
Thickness ,, ,, (at prominent costae) . . .	?40 ,,	44 ,,
Umbilicus	39 ,,	40 ,,

There is particularly good agreement with the coarse form figured by Brongniart. The keel is narrowed at its base, like that of the form described below as *D. sp. nov.* or of Ooster's *A. roissyanus* (d'Orbigny) *varietas*.* The extremely pronounced forward sweep of the costation, near the end of the large example (see fig. 2, Pl. XXV), is particularly striking. This probably represents the mouth border with its rostrum, but unfortunately the latter is not perfectly preserved.† The length of the body-chamber is well over half a whorl; the last few (approximate) suture-lines are very simple but could not be exposed sufficiently well for complete delineation. What can be seen differs from the suture-line figured by Pictet‡ (fig. 5 *c*) in having shorter and wider elements and from that of fig. 2 *c* in having simpler outlines. The internal portion shows part of the dorsal saddle, but the antisiphonal lobe is hidden by matrix that did not permit of further preparation.

* 'Catal. Céph. Foss., etc.,' 1860, iv, p. 144, pl. xxvi, figs. 6 and 7.

† d'Orbigny's figure (*loc. cit.*, pl. lxxxviii, fig. 1) probably is restored and composite, for according to the evidence of the example here described, the curve of the costae near the end is quite different, and all tuberculation has disappeared.

‡ In Pictet & Roux, 'Moll. Foss. Grès. Verts.,' 1847, pl. viii.

The smaller example is distinguished from equal-sized European specimens of the *subcristatus* type, as figured by d'Orbigny and Sowerby (in Fitton), in having straighter and more rigid costation. This is reminiscent of *D. cornutum*, and some fine specimens of the latter species, much larger than Pictet's type, from the Astier Collection in the British Museum (*e.g.* Nos. 37610 [88]) show comparable ornamentation near the end, after decline of the tuberculation has set in. Only the thickness is far greater in Pictet's species than in *D. cristatum*, and the prominences on the inner whorls are blunter.

The *Schloenbachia* sp., recorded by Crick* from the Middle Tributary of the Manuan Creek, and compared with d'Orbigny's *A. delaruei* and Pictet's *A. cornutus*, is a badly preserved and immature example of a *Dipoloceras;* but a larger fragment (No. C18301) of a similar form, close to both the large *D. cornutum* from Escragnolles, mentioned above, and to the typical *D. cristatum* in Brongniart, was worked out of the matrix of one of the Nautili described on p. 244 by Mr. Crick, but was not referred to in the paper.

The large example, in peripheral view of the final, costate portion, somewhat resembles Marcou's *A. shumardi*†; but that species has no "flares," has weak outer and strong inner tubercles, and is transitional from *Dipoloceras* to *Subschloenbachia*.

Locality.—Manuan Creek. Coll. Resident Magistrate, Ubombo.

5. Dipoloceras quadratum, sp. nov.

(Pl. XXV, figs. 3 *a–c.*)

Cf. 1847. *A. bouchardianus* (d'Orbigny) Pictet. In Pictet & Roux, Moll. Foss. Grès. Verts., p. 350, pl. viii, fig. 9.

This species is based on a specimen (No. 4955) of the following dimensions:

Diameter	43 mm.
Height of last whorl . .	40 per cent. of the diameter.
Thickness ,, ,, . .	? 45 ,, ,, ,,
Umbilicus	30 ,, ,, ,,

Like the closely comparable specimen figured by Pictet, this

* *Loc. cit.* (1907), p. 247, B.M., No. C18308.

† 'Geology of N. America' (1858), p. 33, pl. i, fig. 1 (misspelt *schumardi* on plate), holotype in B.M. (Geol. Soc. Coll.) No. 12662. The geological position of this form, in the Upper Duck Creek Formation, below the Fort Worth Beds with *Subschloenbachia leonensis*, seems to correspond with that of the European *Dipoloceras cristatum*.

Ammonite is distinguished from the true *D. bouchardianum*, d'Orbigny,* by its evolute and square whorls, with a wide, carinati-sulcate ventral area. It may be considered to form a transition towards the *subcristatum* and *subinflatum* groups, as d'Orbigny's compressed type has leanings towards *Pseudophacoceras roissyanum*, d'Orbigny sp. The resemblance of Pictet's example to *D. subcristatum* consists chiefly of the peculiar trifurcation of some of the costae; whereas in the smaller Zululand specimen, comparable with the inner whorls of Pictet's form, this resemblance is due to the slightly greater prominence of one or two of the costae, though there are no conspicuous flares, such as are characteristic of the *cristatum* group.

The present example, on the other hand, does not show the umbilical tuberculation that is so notable a feature in Pictet's much larger specimen, but, as in d'Orbigny's species, a pair of costae may be thickened where they meet at the umbilicus. The example, perhaps, might be thought to represent only the inner whorls of a large specimen, such as Boule, Lemoine and Thévenin's "*Schloenbachia* cf. *bouchardiana*."† It appears probable, however, that the last half-whorl, at least, of the present example belongs to the body-chamber, though the suture-line, unfortunately, cannot be made out.

The Madagascar specimen, referred to above, which is larger than any European form of this group, and therefore difficult to compare, apparently does not agree either with d'Orbigny's species or with the species here discussed, and may represent a new type. In *D. subinflatum*, Pictet sp.,‡ and in *D. rouxianum*, Pictet sp.,§ the umbilical tuberculation is far too pronounced.

Forms comparable with the present species, but not with d'Orbigny's form, are found in bed VIII at Folkestone, but in the succeeding zones, forms belonging to the group of *Brancoceras symmetricum*, Sowerby sp., are common, and often confused with *D. bouchardianum*.|| Other transitional forms of *Dipoloceras* from the *cristatus* zone of Folkestone differ from the present species in having the point of bifurcation of the costae moved farther away from the umbilicus.

Locality.—Middle Branch, Manuan Creek. Coll. W. J. Wybergh.

* *Loc. cit.* (1840), p. 301, pl. lxxxviii, figs. 6–8.

† *Loc. cit.* (1907, ii), p. 39, pl. ix, fig. 11.

‡ In Pictet and Roux, *loc. cit.* (1847), p. 104, pl. x, fig. 1. A specimen in the British Museum, also from Mt. Saxonet (No. C. 10399) forms a transition to *Brancoceras symmetricum* (Sow.).

§ *Ibid.*, p. 99, pl. ix, figs. 2 *a*, *b*.

|| See Price, "On the Gault of Folkestone," 'Q.J.G.S.,' vol. xxx (1874), table on p. 362; and Jukes-Browne and Hill, 'Cret. Rocks Britain,' I, "Gault and Up. Gr. Sd. of Engl.," tables on pp. 82 and 459.

6. Dipoloceras sp. nov.

(Pl. XXVI, figs. 5 *a*, *b*.)

Cf. 1910. *Schloenbachia* n. sp. Böse, "Mon. Geol. & Pal. d. Cerro de Muleros," Bol. Inst. Geol. Mexico, No. 25, p. 74, pl. viii, fig. 6.

The fragment (No. 4903) to be described, unfortunately, is too incomplete to justify the creation of a new species, but the characters of the body-chamber, as well as of what is preserved of the inner whorls, clearly distinguish it from the previously described forms of this group. The measurements, based on the restoration of the complete shell, shown in fig. 5 *a*, are:

Diameter	39 mm.
Height of the last whorl .	46 per cent. of the diameter
Thickness ,, ,, .	35 ,, ,, ,,
Umbilicus ,, ,, .	22 ,, ,, ,,

Except for the smaller umbilicus of the present example, these measurements agree with those of *D. sergipense*, White sp.* There is a similar strong outer tubercle and high keel, but the latter, in the Zululand specimen, is of the shape of that of *A. roissyanus* (d'Orbigny) *varietas*, Ooster,† or of many specimens of *Dipoloceras cristatum*, that are well enough preserved—that is to say, it is thinner at its base than at its middle height, and becomes thin and sharp again at the edge. But the present species has a second small tubercle half way between the much more prominent outer tubercle and the umbilical suture. Similar bituberculation is shown in some varieties of *D.* (*Mojsisovicsia ?*) *delaruei*, d'Orbigny sp., *e. g.* the form figured by Parona and Bonarelli,‡ only in the present species it is more developed, and altogether the new form, like *Mojsisovicsia ventanillensis*, Gabb sp., shows a decided resemblance to the later *Subschloenbachia*. Of the bituberculate forms included by Böse in "*Schloenbachia* n. sp.," his figs. 6–8, pl. viii, represent a closely comparable form; but the inner tubercle is hardly indicated, whereas in figs. 4 and 5 it is the outer tubercle that is not prominent enough. Besides, both these examples are represented as having an acute periphery instead of a high keel on a flat periphery, such as is characteristic of *D. sergipense* and the *delaruei* group.

* "Contrib. Pal. Brazil," 'Arch. Mus. Nac. Rio de Janeiro,' vol. vii (1887), p. 221, pl. xxiv, figs. 1 and 2. A specimen intermediate between this species and *D.* (*Mojsisovicsia ?*) *delaruei* (d'Orbigny) in the British Museum (No. C4255), from Velez, Colombia, with a smaller umbilicus, is still nearer to the present example, and also shows the steep forward edge of the costae very well.

† 'Catal. Céph. Foss.,' etc., 1860, iv, p. 144, pl. xxvi, figs. 6 and 7.

‡ "Foss. Alb. d'Escragnolles," 'Pal. Ital.,' vol. ii (1896), p. 88, pl. xi, fig. 9 only.

D. colladoni, Pictet sp.,* is too compressed and too evolute; and, in the sectional view, the outer tubercle is not prominent enough; but the character of the ribs, with an occasional rib that does not reach to the umbilical border, is very similar. There apparently is no inner tubercle in this small species, but the high umbilical border, shown in Pictet's fig. 1 *b* indicates how the line of minute inner tubercles (of some of the costae) of the specimen here described first arises. On the other hand, in such a form of *Subschloenbachia?* as Quenstedt's evolute "*A. varicosus*,"† with the *Dipoloceras* keel still retained, the inner tubercle has become strongly developed, and the ribbing has lost its flexiradiate and peculiar wedge-shaped character.

Locality.—Middle Branch, Manuan Creek. Coll. W. J. Wybergh.

Gen. PSEUDOPHACOCERAS, nov.‡

Genotype: *A. roissyanus*, d'Orbigny, 'Pal. Franç. Ter. Crét.,' p. 302, pl. lxxxix.

7. Pseudophacoceras manuanense, nov.

(Pl. XXV, figs. 1 *a–d*.)

1907. *Schloenbachia* sp., Crick. "Cret. Foss. Natal (III)," Third Report, Geol. Surv. Nat. and Zulul., p. 240.

This species is represented by two specimens, the larger of which is taken as type. Their dimensions are as follows:

	No. 2725.	No. 2726.
Diameter . . .	235 mm.	(at) 80 mm.
Height of last whorl	45 per cent.	52 per cent. of the diameter.
Thickness ,, ,,	20 ,,	22 ,, ,, ,,
Umbilicus . .	21 ,,	15 ,, ,, ,,

At a diameter of 170 mm. the umbilicus of the large example is only 16 per cent., and the uncoiling that leads to an excentrumbilicate (scaphitoid) shell is confined to the last half-whorl, belonging to the body-chamber. At a diameter of 80 mm. there are 20–22 primary ribs per whorl; they bifurcate at varying distances from the umbilical border, and one branch bifurcates again higher up, so that generally

* In Pictet & Roux, *loc. cit.* (1847), p. 89, pl. viii, figs. 1 *a, b*. Pictet & Campiche (*loc. cit.* [1859], p. 175) wrongly united this species with J. de C. Sowerby's *Brancoceras symmetricum*.

† *Non* Sowerby ('Cephalop.,' 1849, pl. xvii, fig. 2).

‡ Dealt with in the writer's Angola paper, above referred to.

there are three secondaries to each primary rib.* On the outer whorl the ornament is considerably weakened. The umbilical border is gently rounded and the slope slightly concave, except on the innermost whorls. The keel is very prominent and narrowed at its base, as in the form of *Pseudophacoceras* described by Ooster and in many *Dipoloceras* (see *ante*, pp. 277 and 280).

The smaller example, which has portions of the outer whorl preserved (not shown in fig. 1 *c* of Pl. XXV), has its last suture-line at a diameter of about 115 mm., when, here also, excentrumbilication sets in. Unfortunately only the umbilical portion of the outer whorl here is preserved. The (last) suture-line of the larger example, taken at a diameter of 160 mm., apparently differs from that of the smaller specimen, the latter (in fig. 1 *c*) being nearly half a whorl away from the beginning of the body-chamber, at a diameter of 80 mm. But though comparison at the same (relative) size is impossible without breaking up the type, the dissimilarity, in the writer's opinion, is accounted for by the fairly frequently observed simplification of the last few suture-lines, in Ammonites generally, often accompanied by equalisation of the elements. This is a phenomenon of individual growth and cannot be applied to phylogeny; and it seems to the writer that the suture-line of the smaller specimen (fig. 1 *c*) indicates that descendants of this group would show the *Sphenodiscus* type of suture-line, with adventitious elements.

The suture-line of the present species differs from that of the less compressed *P. multifidum*, Steinmann sp.,† its nearest relative, chiefly in the greater depth of the ventral lobe and the presence of a larger number of auxiliaries (corresponding to its greater involution)—a character that also is not shown in the more evolute form figured by Lasswitz.‡ The suture-line of d'Orbigny's *A. roissyanus* § has this deep ventral lobe, but differs in the auxiliaries. On the other hand, in a specimen of *P.* aff. *roissyanum* (from Escragnolles, in the British

* This type of ornament is somewhat reminiscent of that of *Neoharpoceras* [gen. nov.] cf. *hugardianum* (d'Orbigny) in Pictet (*loc. cit.*, Pictet & Roux, 1847, pl. x, fig. 3), but the suture-lines are very different in the two stocks. (Genotype = *A. hugardianus*, d'Orbigny, 'Pal. Franç. Ter. Crét.,' pl. lxxxvi, figs. 1 and 2.)

† "Üb. Tithon and Kreide i. d. Peruan. And.," 'N. Jb. f. Min., etc.,' II, 1881, p. 139, pl. vii, fig. 1 [*Schloenbachia acuto-carinata* (Shum. sp.) Marcou].

‡ "Kreide-Amm. v. Texas," 'Geol. and Pal. Abh.,' N.F., vol. vi, Heft 4, 1904, p. 22, pl. v, fig. 2. Schlagintweit (see below) questions Lasswitz's identifications, but the present examples indicate that in the case of the secondaries it occasionally is impossible to say whether they result from dichotomous branching or are simply intercalated.

§ *Loc. cit.* (1840), p. 302, pl. lxxxix, figs. 1–3.

Museum, No. 50065), transitional to *P. mirapelianum*, d'Orbigny sp. there is only one auxiliary lobe less than in the present specimen, and the suture-line describes a similar curve, but the lateral lobe is slightly deeper than the ventral lobe.

Shumard's original *P. acuto-carinatum** is more evolute and much more distantly costate than the present species; but the form figured as "*Sonneratia acuto-carinata*, Typus," by Lasswitz† forms a closer approach to *P. multifidum* and to *P. manuanense* than to Shumard's type or to d'Orbigny's species.‡ The specimen figured by Böse§ as *Schloenbachia* aff. *acuto-carinata* is similarly closely costate, but differs from the Zululand species in the whorl-section, and in the very pronounced forward projection of the peripheral portion of the costae. A specimen of *P.* cf. *peruvianum*, v. Buch, from Velez, Colombia, in the British Museum,‖ shows similar peripheral projection; but the ribs, all of which are single, have the peculiar perpendicular forward edge, reminiscent of such large examples of *P. roissyanum*, d'Orbigny sp., as that figured by Parona and Bonarelli.¶ The suture-line of the evolute Mexican example, on the other hand, shows great resemblance to that of the large specimen here figured, except that there are two more auxiliary lobes in the latter.

One of the specimens included by White** in his *A. buarquianus* seems close to the present species, but the type (White's figs. 3 and 4) has distant and single costae.

The fragments recorded by Crick, since mounted in plaster, probably belong to a large specimen of this form. *Sphenodiscus* sp.,

* In Marcy, "Explor. Red River Louisiana" (1853), Appendix E, 'Pal.,' p. 209, pl. iii, fig. 1. The thickness of this form appears to be only about 20 per cent. of the diameter.

† *Loc. cit.* (1904), p. 21, pl. xvii (v), fig. 1, = *A. peruvianus*, Marcou, V, 1 *a*, *b* only, *non* v. Buch (B.M., No. 12718, Geol. Soc. Coll.).

‡ Schlagintweit ("D. Fauna d. Vracon und Cenoman in Peru," 'N. Jb. f. Min., etc.,' Beil. Bd. xxxiii (1912), pp. 64 and ff., includes in "*Schloenbachia*" *roissyana*, d'Orbigny sp., not only *P. acuto-carinatum* (already united with d'Orbigny's species by Lasswitz, 1904, and Douvillé, 1906), *P. multifidum*, *P. mirapelianum* (as varieties), further *P. buarquianum* (White), *P. peruvianum* (v. Buch), *P. carbonarium* (Gabb), *P. belknapi* (Marcou) [holotype in B.M., No. 12663, Geol. Soc. Coll.], and other comparable forms, but, probably quite wrongly, also Lea's *A. americanus*, apparently a *Pulchellia*.

§ *Loc. cit.* (1910), p. 65, pl. ii, figs. 1–3.

‖ No. C4266, comparable with fig. 6 of pl. i in v. Buch ('Petrif. Recueill. en Amer. p. M. A. Humboldt et M. Ch. Degenhardt,' Berlin, 1839, p. 5), and more closely costate than *A. peruvianus*, Marcou, V, 1, *non* v. Buch (B.M., No. 12664 Geol. Soc. Coll. and writer's coll.).

¶ *Loc. cit.* (1896), p. 88 (36), pl. ii, fig. 8.

** *Loc. cit.* (1887), p. 222, pl. xxiv, figs. 5 and 6 only.

figured by Boule, Lemoine and Thévenin* from the "Lower Cenomanian" of Madagascar, may represent an allied form of this genus, distinguished by more numerous auxiliaries.

Locality.—Manuan Creek. Coll. Resident Magistrate, Ubombo.

Gen. SUBSCHLOENBACHIA, nov.

Genotype: *A. rostratus*, J. Sowerby, 'Min. Conch.,' pl. clxxiii (Oxford University Museum).

8. Subschloenbachia prerostrata, nov.

(Pl. XXIV, fig. 10.)

A fragmentary example (No. 4970), consisting of portions of two whorls (completely septate) of a specimen of 160–170 mm. diameter, belongs to a type of *Subschloenbachia* that is found in Southern Europe, and to which probably the large example figured by Boule, Lemoine and Thévenin† is related, though the latter acquires single costation, resembling that of *S. stoliczkai*, n. nov.,‡ at an earlier stage.

The whorl-section at first is wider than high,§ but becomes quadrate at a later stage. *S. picteti*, n. nov.,|| has a less depressed whorl-section, and shows less coarse ornamentation; on the other hand, *S. orbignyi*, n. nov.,¶ or at least the French examples that the writer would consider typical of d'Orbigny's form, agree in the more robust ornamentation, but are compressed. On the shell there is very distinct spiral striation, but the cast is almost smooth. The suture-line has deeper lateral lobes than that figured by d'Orbigny. A peculiar feature is a distinct groove on the umbilical slope (Pl. XXIV, fig. 10, marked by arrows) of the cast, near the end.

S. stoliczkai, nov., which has a depressed whorl-section,** shows the ornamentation of *S. aequatorialis*, Kossmat sp., on its inner whorls; and its near ally, *S. pachys*, Seeley sp., is too closely costate and less tuberculate. The depressed examples of the quadrituberculate *perinflata* group (n. nov. = *A. inflatus*, pars, Pictet & Campiche, pl. xxii, fig. 3 only), and others described in the Angola paper already referred to, are distinguished by their double row of outer tubercles.

Locality.—Middle Branch, Manuan Creek. Coll. W. J. Wybergh.

* *Loc. cit.* (II, 1907), p. 50, pl. xi, fig. 5.

† *Loc. cit.* (II, 1907), p. 40, pl. ix, fig. 7.

‡ = *A. inflatus* (Sow.) Stoliczka, *loc. cit.*, pls. xxvii and xxix, fig. 2.

§ In fig. 10 of Pl. XXIV, the height of the smaller whorl should have been only 27 mm.

|| = *A. inflatus*, Pictet, in Pictet & Roux, 1847, pl. ix, fig. 6, *e.g.* B.M., No. C3822 (holotype of species) and No. 62116.

¶ = *A inflatus*, d'Orbigny, 1840, pl. xc, *e.g.* B.M., No. C901 (holotype of species; thinner, more distantly, coarsely [and recte-] costate, than *S. picteti*).

** Stoliczka, *loc. cit.*, pl. xxix, fig. 2.

9. Subschloenbachia cf. trinodosa, Böse sp.

(Pl. XXV, fig. 4.)

1910. *Schloenbachia trinodosa,* Böse. "Mon. Geol. & Pal. Cerro de Muleros," Bol. Inst. Geol. Mexico, No. 25, p. 78, pl. x, figs. 2–4.

A whorl-fragment (No. 4972), about 100 mm. long, is comparable with the smaller specimen figured by Böse, but has a slightly more depressed whorl-section. The spiral ornamentation, also, is very well preserved on this (body-chamber?) fragment, whereas the Mexican original, a septate cast, does not show it. The present example is distinguished from the form above described (*S. prerostrata*) by its whorl-section, which difference results in very dissimilar ventral aspects of the two species. The trituberculation also is a distinctive feature of the form here described, quite different from the ornamentation of the earlier group, with the high umbilical tubercle almost at the middle of the side.

Forms similar to this species occur in the Cambridge Greensand and in the Red Chalk, and there exist (at Blackdown) transitions to *S. aequatorialis,* Kossmat sp., on the one hand, and to the bituberculate species, referred to below, on the other.

Locality.—South side of Manuan Creek Valley. Coll. W. J. Wybergh.

10. Subschloenbachia bispinosa, nov.

(Pl. XXIV, fig. 9.)

This species is based on a somewhat fragmentary specimen (No. 4993) that is weathered on one side, so as to expose, in a natural section, the distant septa of the inner whorls and the more approximate septa of the last quarter of a whorl, which shows the beginning of the body-chamber. The dimensions are as follows:

Diameter	. . . .	148 mm.
Height of the last whorl	.	32 per cent. of the diameter.
Thickness ,, ,,	.	30 ,, ,, ,,
Umbilicus	. . . .	44 ,, ,, ,,

The peculiar whorl-section (Pl. XXIV, fig. 9), with its depressed outer tubercle, shows the distinctive features of this form. The inner whorls agree in ornamentation with those of the Bellegarde variety of *S. prerostrata* (B.M., No. C10547, less depressed than fig. 10, Pl. XXIV), and show spiral striation; the outer whorl, with only a peripheral and an umbilical tubercle (on the ribs that reach to the umbilicus) is

comparable with that of one of Etheridge's Queensland specimens* and of a common Blackdown form (*e. g.* B.M., No. 52043). This latter is interesting, since it is connected by quite a series of transitions with *S. orbignyi* on the one hand, and with compressed forms converging towards *Prohysteroceras*† *goodhalli* on the other. The Blackdown form stands in the same relationship to *S. bispinosa* as *S. orbignyi* to *S. picteti*—that is to say, the Zululand species here described, like *S. picteti*, represents the less coarsely ornamented type. Near the end of the shell the costae become single and equally bituberculate, and on the cast show no trace of spiral striation. The Angola *S. cycloceratoides*, Spath, has similar lateral ornament, but is compressed and has no distinct keel, but merely an angular periphery, like certain *Acanthopleuroceras.*

S. leoennsis, Conrad sp.,‡ includes a group of bispinous forms that have a certain resemblance to the specimen here described. Whether, however, such forms as, *e. g.*, Hill's *S. leonensis*,§ are identical with Conrad's type seems doubtful. Lasswitz|| probably has misinterpreted the species altogether, putting it in the Senonian.

A worn fragment (No. 4971) of the body-chamber of a large specimen, in which the costation has become single, in whorl-section and peripheral aspect agrees with the species here described. In somewhat similar body-chamber fragments of *S. stoliczkai* from Angola, the peripheral tubercle is more prominent, elongated longitudinally and projected upwards.

Locality.—Middle Branch, Manuan Creek. Coll. W. J. Wybergh.

Family: LYELLICERATIDÆ.

Gen. STOLICZKAIA, Neumayr.

11. Stoliczkaia sp. ind.

1888. *Stoliczkaia dispar* (d'Orbigny) Choffat. In Choffat & de Loriol, "Matériaux . . . Angola," Mém. Soc. Phys. and d'Hist. Natur. Genève, t. xxx, No. 2, p. 69, pl. ii, fig. 6 ?.

1894. *St. clavigera* (Neumayr) Kossmat. "D. Bedeut. d. Südind. Kr. F.," Jb. K.K.R.A., vol. xliv, p. 465.

* "Low. Cret. Foss., etc.," II, Ceph. ii, 'Records Austral. Mus.,' vii, 4 (1909), pl. lxvi, fig. 1 only.

† Gen. nov. Genotype = *P. wordiei*, nov., a new Angola species of the *candollianum-goodhalli* group.

‡ "Descr. of Cret. and Tert. Foss.," 'Geol. Rep. Mexican Boundary' (1857 ?), p. 160, pl. xvi, figs. 2 *a*, *b*.

§ *Loc. cit.*, 1901, pl. xxxvi, figs. 1, 1 *a* (as *A.* (*Schloenbachia*) *leonensis*, Römer).

|| *Loc. cit.*, p. 23.

A whorl-fragment (No. 4939) of a specimen of about 35 mm. diameter, with the umbilical portion imperfectly preserved, appears to belong to a flexicostate form of this genus, like some of the varieties of *S. dispar*, d'Orbigny sp., figured by Choffat and by Pictet & Campiche.* The square whorl-section agrees with that of *S. clavigera*, Neumayr,† but in this species, as in the still more quadrate-whorled *S. tetragona*, Neumayr,‡ the costation is too straight. There are nine ribs on the fragment, very thick on the periphery, and of varying lengths.

The specimen of *S. clavigera* from Madagascar, figured by Boule, Lemoine and Thévenin,§ has the inner whorls too poorly preserved for comparison with the much smaller fragment here described.

It should be mentioned that there is no indication of tuberculation on the periphery, such as is shown in Choffat's figs. 5 and 7, in Pictet and Campiche's fig. 1 *b*, and in Stoliczka's fig. 3—a feature that becomes permanent in the later *Mantelliceras*, e. g. *M. hoplitoides*, Lasswitz,‖ and *M. martimpreyi* (Coquand), Pervinquière.¶ *Mantelliceras* is known to occur in Zululand,** but the presence of a *Stoliczkaia* in the Manuan Creek Fauna is of interest in view of the occurrence of this genus in India and Madagascar, on the one hand, and in Angola and North Africa on the other.

Locality.—South side of Manuan Creek Valley. Coll. W. J. Wybergh.

* *Loc. cit.* (1860), pl. xxxviii. *S. dispar*, d'Orbigny sp., and *S. notha*, Seeley sp., are too compressed and too rounded ventrally.

† In Stoliczka, *loc. cit.* (1865), pl. xlv, fig. 1 (refigured in Lasswitz, 'Kreide A. v. Texas,' *loc. cit.*, pl. iv, fig. 2), and fig. 3 (refigured Kossmat, *loc. cit.*, pl. xxiv [x], fig. 2). Kossmat included the Angola specimens in *S. clavigera* Neumayr, but they belong to several distinct varieties.

‡ In Stoliczka, *loc. cit.*, pl. xlv, fig. 2.

§ *Loc. cit.* (1907), pl. ix, fig. 1, p. 33 (apparently reduced by half, though stated to be natural size).

‖ *Loc. cit.* (1904), p. 19, pl. iii (xv), fig. 3. The suture-line of this form (text-fig. 4, p. 19) is little advanced from that of *Lyelliceratidæ*, so that *Mantelliceras* is not a direct descendant of *Stoliczkaia*, but more or less a parallel development with *Neophlycticeras*, nov. (genotype = *A. brottianus*, d'Orbigny, 'Pal. Franç. Ter. Crét.,' pl. lxxxv, figs. 8–10), and *Stoliczkaia*, of *Lyelliceratidæ*. (See, however, Nowak, "Unters. Cephal. Ob. Kreide Pol.," II. Skaphiten, 'Bull. Acad. Sci. Cracovie,' July, 1911, p. 554, text-figs. 1 and 2.)

¶ *Loc. cit.* (1907), pp. 289 and 389.

** E. g. *M. choffati*, Kossmat sp.

Family: HAMITIDÆ.

Gen. TORNEUTOCERAS, Hyatt.

12. Torneutoceras sp. ind.

1861. *Hamites virgulatus*, Pictet & Campiche (*non* d'Orbigny). "Foss. Ter. Crét. de Ste. Croix," Mat. Pal. Suisse, III, pt. 2, p. 85, pl. liv, figs. 7 *a*—*d* only.

A fragment (No. 4967), about 20 mm. in length, and slightly curved, has seven thick and round ribs that are very prominent on the ventral side but disappear on the dorsum, so that the concave side of the shell appears quite smooth. This agrees with the ornamentation common to several species of "*Hamites*"; but the circular cross-section and very slight obliquity of the ribs suggest comparison with the above form. The example, however, is only preserved as a very poor cast in a brownish, friable, sandy matrix, so that its identification must remain doubtful.

Specimens of *T. virgulatum* from Angola (B.M. No. C20130–1) show very similar ornament, but a more compressed section, like the types of Brongniart and d'Orbigny, and Pictet & Campiche's fig. 6.

Some of the examples figured by Pictet & Campiche on pl. li as *Anisoceras alternatum* (Mantell) show some resemblance to the fragment here described (*e. g.* fig. 6), and it should be mentioned that there is a specimen of a comparable form of *Anisoceras* in the British Museum (No. C18300) from the South Branch of the Manuan Creek, preserved in a similar matrix, but not referred to in Crick's paper. The tuberculation of alternate ribs, however, is very distinct in this fragment.

Locality.—South side of Manuan Creek Valley. Coll. W. Wybergh.

Family: ANISOCERATIDÆ.

Gen. ANISOCERAS, Pictet.

13. Anisoceras sp. ind.

(Pl. XXVI, fig. 7.)

Cf. 1861. *Helicoceras thurmanni*, Pictet & Campiche. "Foss. Ter. Crét. Ste. Croix," Mat. Pal. Suisse, III, pt. 2, p. 118, pl. lvi, fig. 5.

A small fragment (No. 4982) of a completely septate, free and unsymmetrical whorl resembles the above form in size, coiling and quadrituberculation, but the costae are broader and all equal. The tubercles are less prominent, agreeing in this respect with those of *Anisoceras pseudopunctatum*, Pictet & Campiche,* and the costae are slightly weakened between the ventral tubercles, but flattened, after the manner of those of *A. perarmatum*, Pictet & Campiche,† between the ventral and lateral tubercles.

"*Helicoceras*" *astierianum*, d'Orbigny in Parona and Bonarelli,‡ shows only slightly closer coiling than the present form, and other comparable forms, *e.g. Turrilites elegans*, Pictet & Campiche, pars, *non* d'Orbigny,§ have somewhat similar ornamentation. It appears most probable, however, that the example here recorded represents part of the helicoid initial whorls of an *Anisoceras* of the typical group of *A. saussureanum*, Pictet,‖ and *A. oldhamianum*, Stoliczka.¶ The suture-line differs from that of the typical *Anisoceras* in the wide external saddle, and from those equally simple ones of certain Hamitids (*Torneutoceras*) in the unsymmetrical first lateral lobe (Pl. XXVI, fig. 7).

Locality.—Low Ridge, about three miles east of foot of Lebombo Mountains, north of M'Kusi River, due east of Ubombo. Coll. W. J. Wybergh. This is the only specimen in the present collection from this locality, further north than that of any of the other (post-Aptian) Cephalopoda; but the facies appears to be the same as that of the Albian Manuan Creek fauna.

FAMILY: TURRILITIDÆ.

GEN. TURRILITES, Lamarck.

14. TURRILITES cf. GRESSLYI, Pictet & Campiche.

1907. *Turrilites gresslyi.* Boule, Lemoine & Thévenin: "Céph. d. Diego-Suarez," Ann. d. Pal., vol. ii, p. 57, pl. ii, fig. 2.

A small portion of a *Turrilites* (No. 4954), with five rows of tubercles, agrees with the example from Madagascar, in having the upper two tubercles very close together. Since these coincide with the upper

* *Loc. cit.*, p. 74, pl. lii, figs. 1–3.

† *Ibid.*, pl. xlix, figs. 2, 4 *a*.

‡ *Loc. cit.* (1896), p. 102 (50), pl. v, fig. 13.

§ *Loc. cit., e.g.* pl. lvi, fig. 10 *b*.

‖ In Pictet and Roux (1847), p. 118, pl. xiii (*Hamites*).

¶ *Loc. cit.* (1866), p. 175, pl. lxxxiii, figs. 1–4.

suture and the lowest (indistinct) row of tubercles with the lower suture, only the two median rows are clearly visible at the middle of the sides, as pointed out by Boule, Lemoine and Thévenin. In the Ste. Croix specimens, however, the three rows of lateral tubercles appear to be more equal-sized, and the upper two rows are not so close together.*

Specimens of *T. cenomanensis*, Schlüter,† from Wiltshire and Wissant, France, of undoubted Cenomanian age (zone of *Schloenbachia varians*), show the closest agreement with the present fragment in the arrangement of the tubercles; but shape and coiling of the whorls are slightly different in the Cenomanian species. The *Turrilites* recorded by Crick‡ from the Cenomanian of False Bay, Zululand, belong to different species.

Locality.—South side of Manuan Creek Valley. Coll. W. J. Wybergh.

2. NAUTILOIDEA.

Gen. CYMATOCERAS, Hyatt.

15. Cymatoceras manuanense, G. C. Crick sp.

1907. *Nautilus manuanensis*, G. C. Crick. *Loc. cit.* (Third Report), p. 243, pl. xv, figs. 6, 6 *a*.

This species was founded for a "less tumid, more finely ornamented and more narrowly umbilicated shell than *Nautilus pseudo-elegans*, d'Orbigny." Crick stated that it was "numerously represented in Mr. Anderson's collection from the Manuan Creek," but it is possible that the specimens do not all belong to the same species, and that some fragments (*e. g.* B.M., No. C18283) belong to such a Senonian *Cymatoceras* as *Nautilus elegans* (Sowerby) in Boule, Lemoine and Thévenin;§ for Albian and Senonian forms occur together at the south branch of the Manuan Creek, and there are slight differences in the matrices. Taking the figured example (B.M., No. C18282) as type of Crick's species, the differences from d'Orbigny's *N. pseudo-*

* Pictet et Campiche, 'Ter. Crét. de Ste. Croix,' 2nd ser. (1861), p. 132, pl. lvii, figs. 11–13.

† *Loc. cit.* (1876), p. 11 (131), pl. ii (xxxvii), figs. 6–8. (Cf. *Turrilites tuberculatus* (pars) Sharpe, *loc. cit.*, III, 1856, pl. xxv, fig. 3 only.) (Writer's Coll.)

‡ *Loc. cit.* (1907), pp. 173–8.

§ *Loc. cit.* (1907), p. 66, pl. xv, fig. 4.

*elegans** seem to be a less broad periphery and less coarse, if equally distant, costation. The proportions of diameter to thickness (3 : 2) are about the same in the two forms, but on account of its broad periphery d'Orbigny's figure appears considerably more tumid than that of *N. manuanensis*, as does the figure of the type-specimen given by Foord.† On the other hand, *C. pseudo-elegans* is of Barremian age, whereas among Albian forms the example figured as *N. albensis*, d'Orbigny, by Pictet & Campiche‡ appears to be almost indistinguishable from Crick's species. The differences are the slightly greater thickness of the European species and the less pronounced peripheral sinus in the costation, possibly also the absence of bifurcation. These may not be characters of specific importance, for sexual dimorphism is proved in the recent *Nautilus*, and among some fifteen presumably Albian *Cymatoceras* from the Manuan Creek there are no two alike.

One example in the collection (No. 4991) of the following dimensions—

Diameter	185 mm.	
Thickness	120 ,,	(?)

differs from the holotype only in showing fine costation at the end of the shell, which, then, is still septate, whereas on the body-chamber of Crick's figured specimen, in the one place where the test is preserved, the ornament does not show this tendency to become finer and closer.

C. virgatum, Spengler sp.,§ has coarser ornamentation than *C. manuanense*; and *C. carlottense*, Whiteaves sp.,|| differs in its small and shallow umbilicus.

C. crebricostatum, Blanford sp.,¶ differs from the form here described chiefly in its more sinuous septa, and in a less linguiform peripheral sinus of the costae.

Locality.—Middle Branch, Manuan Creek. Coll. W. J. Wybergh.

16. Cymatoceras cf. manuanense, G. C. Crick sp.

One example (No. 4990) agrees with Crick's holotype of *N. manuanensis*, but the coarse plication only appears on the shell of the ventral

* 'Pal. Franç. Ter Crét.' (I), 1840, p. 70, pls. viii and ix, fig. 1. The ratio of diameter to thickness is 3 : 2 according to the text.

† 'Catalogue Foss. Ceph. Brit. Mus.' (II), 1891, p. 253, fig. 59 on p. 255.

‡ *Loc. cit.* (Ste. Croix, I) (1859), p. 134, pl. xvii, figs. 1 *a* and *b* only.

§ *Loc. cit.* (1910), p. 130, pl. xi, fig. 3.

|| "Mesozoic Fossils," I, 'Geol. Surv. Canada,' pt. iv, 1900, p. 269, pl. xxi.

¶ 'Pal. Indica,' I, "Foss. Ceph. Cret. Rocks S. India," 1861, p. 36, pl. xxi, fig. 3, and pl. xxii.

area at a late stage, and up to a diameter of about 90 mm. there are only striae of growth. This is reminiscent of the Barremian *N. pseudo-elegans*, d'Orbigny, the genotype of *Cymatoceras*, and the measurements also agree with those given by the author of this species. These dimensions are, in the specimen here described:

Diameter . . .	180 mm.	
Thickness . . .	115 ,,	(64 per cent. of the diameter)
Height of the last whorl (in siphonal plane) .	65 ,,	

Another apparently Albian but imperfect specimen of a *Cymatoceras*, in the British Museum, No. C18298, not referred to in Crick's paper, shows a similarly late appearance of costation. This and another example (No. C18299) of the same imperfect set of *Nautili*, not mentioned in Crick's Report, are interesting as showing approximation of the last few septa (see Crick, 'Proc. Geol. Soc.,' No. 979, p. 3, November 11th, 1915).

Foord* describes, from the Gault, a "species which, on the whole, agrees very closely with Pictet and Campiche's description and figures of *N. albensis*, but differs from it in respect that up to a certain [variable] stage of growth the test is smooth. . . ." The present example thus would seem to stand in a similar relation to *C. manuanense*.

One of the imperfect specimens mentioned by Crick,† on p. 245 (B.M., No. C18295) as "probably referable to *Eutrephoceras*" may belong to the same species as the form here described, and at any rate is a *Cymatoceras*. Another of the examples (C18294) is referable to *Cymatoceras kayeanum*, Blanford sp., or a similar compressed species, whereas the remaining two specimens (Nos. C18292 and 93), preserved in limonite, may be of Senonian age.‡

Locality.—Middle Branch, Manuan Creek. Coll. W. J. Wybergh.

17. Cymatoceras cf. albense, d'Orbigny sp.

1859. *Nautilus albensis*, d'Orbigny. In Pictet & Campiche, Pal. Suisse, 2nd ser., p. 134, pl. xvii, figs. 1 *a* and *b* only.

1891. *Nautilus albensis*, Foord. Catal. Foss. Ceph. Brit. Mus., ii, p. 258.

One specimen (No. 4989) differs from the holotype of *C. manuanense*, Crick sp., and from the examples above described in being slightly

* *Loc. cit.* (1891), p. 259.

† *Loc. cit.* (1907), Third Report, pt. ii.

‡ See under *Cymatoceras?* sp. cf. *justum*, Blanford sp., p. 301.

thicker, having a more obtuse sinus on the periphery, and a coarser costation. Its dimensions are:

Diameter . . 135 mm.
Thickness . . 100 ,, (74 per cent. of the diameter).

The whorl-shape agrees with that of the type-figure in Pictet and Campiche, and is more rounded than that of *N. pseudo-elegans*, d'Orbigny, or those of the three forms of *Cymatoceras* described below.

Locality.—Middle Branch, Manuan Creek. Coll. W. J. Wybergh.

18. Cymatoceras, sp. ind.

One example of *Cymatoceras* (No. 4987) differs from the above forms of the *manuanense-albense* group in having a flattened periphery, but it agrees with some of the fragmentary co-types of *C. manuanense*, Crick sp. These differences in whorl-shape are not important; and since the present example is somewhat fragmentary, a definite identification is impossible. The last septum is shown at a diameter of about 90 mm., followed by a portion of the body-chamber.

The smooth earlier whorls, in addition to the flattened periphery, separate it from the holotype of *C. manuanense*, and the finer, dichotomous costation also from *C. albense*. The example agrees with *C. pseudo-elegans*, d'Orbigny sp., in ornamentation, dorsocentran position of the siphuncle and flattened periphery, but is not quite so depressed. *C. kossmati*, Spengler sp.,* has a narrower whorl-section.

Locality.—Middle Branch, Manuan Creek. Coll. W. J. Wybergh.

19. Cymatoceras, sp. nov? ind.

1907. *Nautilus* sp., Crick, *loc. cit.*, p. 244.

Among five specimens of *Cymatoceras*, referred to by Crick as representing "a large species which, in external characters, differs from *N. manuanensis* chiefly in having flatter sides and a more broadly-rounded periphery," four are comparable with the various forms of the *manuanense* group described above, but are not well enough preserved for definite identification. On the other hand, one example (No. C18291) agrees in its squarish whorl-shape and fine ornamentation with a large specimen in the present collection (No. 2589) that has the following dimensions:

Diameter . 190 mm.
Thickness . . 125 ,, (66 per cent. of the diameter).

The ratio of diameter to thickness, about 3 : 2, corresponds with

* *Loc. cit.* (1910), p. 129 (= *N. pseudo-elegans*, Blanford, *non* d'Orbigny).

that of *C. pseudo-elegans* and *C. manuanense*, but the costation is much closer in the present example, and in the specimen described by Crick, than it is in either of the two species mentioned, and the flat, subparallel sides and broader periphery separate them especially from *C. manuanense*.

C. virgatum, Spengler sp.,* and *C. striaticostatum*, Crick sp.,† have the squarish whorl-shape of the form here described, but their costation is much coarser or more distant than that of any of the Zululand examples of the genus *Cymatoceras* here dealt with.

In closeness of costation this species approaches to the Cenomanian *Cymatoceras elegans*, J. Sowerby sp.,‡ though its whorl-shape is more like that of the older *C. pseudo-elegans*, d'Orbigny sp.

Locality.—Manuan Creek. Coll. Resident Magistrate, Ubombo.

20. Cymatoceras cf. kossmati, Spengler sp.

1910. *Nautilus* (*Cymatoceras*) *kossmati*, Spengler. "Untersuch. ü. d. Südind. Kreidef.," IV, *loc. cit.*, p. 129.

One specimen (No. 2588), representing a wholly septate cast, has a portion of the shell preserved at the diameter of 80 mm. and shows only striae of growth at that stage, but obscure folds on the ventral area of the cast of the following portion. Its dimensions are:

Diameter .	120 mm.	
Thickness .	75 ,,	(63 per. cent. of the diameter).

The specimen is a more compressed example of *Cymatoceras* than those described above, and resembles in general appearance *C. kossmati*, but this species is strongly costate already at a considerably smaller diameter. The siphuncle in the present example is nearer the ventral side and not in the median plane.

C. kayeanum, Blanford sp.,§ is a still more compressed species, and is more distinctly costate on the ventral area than the specimen here described.

The Cenomanian *C. imbricatum*, Crick sp.,|| also is too compressed.

Locality.—Manuan Creek. Coll. Resident Magistrate, Ubombo.

* *Loc. cit.* (1910), p. 130, pl. xi, fig. 3.

† *Loc. cit.* (1907), p. 221, pl. xiv, fig. 7.

‡ Non *Nautilus elegans* (Sowerby), in Boule, Lemoine and Thévenin, *loc. cit.* (1907), p. 66, pl. xv, figs. 4 and 5.

§ *Loc. cit.* (1861), p. 41, pl. xviii, fig. 1 (type); Spengler, *loc. cit.* (1910), p. 127, pl. xi, figs. 1 and 2, pl. xii, figs. 2 and 7 *a*.

|| *Loc. cit.* (1907), p. 220, pl. xiv, fig. 6.

21. Cymatoceras? cf. clementinum, d'Orbigny sp.

1840. *Nautilus clementinus*, d'Orbigny. Pal. Franç. Ter. Crét., vol. i, p. 77, pl. xiii *bis*.
1861. *Nautilus splendens*, Blanford. *Loc. cit.* (Foss. Ceph. Cret. Rocks S. India), p. 21, pl. ix, fig 5, pl. x, fig. 1.
1866. *Nautilus splendens*, Stoliczka, *ibid.*, p. 205.
1910. *Nautilus* cf. *clementinus* (d'Orbigny) Spengler. *Loc. cit.* p. 143.

A small specimen (No. 4988), slightly worn, and showing the striae of growth on the test in one or two places, agrees with d'Orbigny's type in whorl-shape and general appearance. At a diameter of 70 mm. the thickness = 45 mm., which is less than the thickness of d'Orbigny's example, but slightly more than that of *N. splendens*, Blanford, the type of which, however, is crushed. Spengler united the two species, which may be open to objections, but since the specimen here described is not well preserved, it also is included in d'Orbigny's well-known Gault species.

Foord * described the species in detail, and was inclined to separate the Indian from the European forms on account of their greater whorl-thickness. Spengler † has since created the var. *indica* of *N. clementinus* for the later Indian form, but the present example is much closer to the European Gault form than to the Trichinopoly species.

Locality.—Middle Branch, Manuan Creek. Coll. W. J. Wybergh.

B. SENONIAN.

AMMONOIDEA.

Gen. PERONICERAS, Grossouvre.

22. Peroniceras cf. dravidicum, Kossmat sp.

(Pl. XXIII, figs. 1 *a–d*.)

1865. *Am. subtricarinatus*, d'Orbigny. Stoliczka, "Cret. S. India," I, p. 54, pl. xxxi, figs. 3, 3 *a–c*.
1895. *Schloenbachia dravidica*, Kossmat. "Unters. S. Ind. Kreidef.," Beitr. Pal. und Geol. Öst.-Ung., vol. ix, Heft 3 and 4, p. 190 (94), pl. xxiii (ix), figs. 3 *a–d*.

* *Loc. cit.* (1891), p. 285 (see there for synonymy).

† *Loc. cit.* (1910), p. 143.

1904. *Peroniceras dravidicum*, Kossmat. Solger, "Foss. d. Mungo-Kreide," Geol. v. Kamerun, II, p. 181, text-fig. 71, p. 182, and 72, p. 183.

A fragment (No. 4950), 72 mm. in length and belonging to a shell just a little larger than the inner whorls of this species, refigured by Kossmat, *i.e.*, of about 85 mm. diameter, has a whorl-height and thickness of 24 mm. It differs from the type of this species only in having the inner tubercle nearer the umbilicus and more prominent, *i.e.* projecting laterally and representing the region of greatest thickness—a character that would approach the present example more to *P. subtricarinatum*. The suture-line, however, has no independent second lateral saddle, like that of *P. subtricarinatum*, but, as in *P. dravidicum*, this second lateral saddle forms only the internal branch of the first lateral saddle, and there is a large umbilical lobe. The principal lobe, though, is deeper in the specimen here described, and the umbilical lobe shorter, than they are in Kossmat's figure. It may also be added that the internal portion of the suture-line is very variable ; the stem of the umbilical branch of the dorsal saddle may be much broader than drawn, so that the details of the umbilical lobe and the size of its lower internal and higher external branch may differ considerably in consecutive suture-lines. No similar suture-line appears to have been observed in any other species of *Peroniceras*, e. g. *P. schneeblii*, Boule, Lemoine and Thévenin sp.,* which may be a related form, occurring in Madagascar, does not show this type of umbilical lobe, nor do the two examples of *Peroniceras* recorded by Crick † from Zululand. One of these, *sp.* α (B.M., No. C18245), compared with *P. tridorsatum*, Schlüter sp., resembles *P. czörnigi*, Redtenbacher sp.,‡ but not the "variety" figured by Grossouvre,§ and has a thinner whorl-section than the present example. Since Crick only figured the external half of the suture-line, the internal portion is here given for comparison (Pl. XXIII, fig. 2). The other example, *sp.* β (No. C18246), is much fatter, and in section and crescent-shaped costation resembles *P. rousseauxi*, Grossouvre,|| but owing to the large size of these specimens comparison with the small European types is difficult. The tricarination is less distinct in this second specimen, and the suture-line also is less well preserved, though very similar in the character of the auxiliary lobes.

* *Loc. cit.* (ii, 1907), p. 37, fig. 20, pl. xii, figs. 2, 2 *a*.

† *Loc. cit.* (Third Report, 1907), pp. 226–7.

‡ *Loc. cit.* (1873), p. 105, pl. xxiii, fig. 4.

§ *Loc. cit.* (1893), pl. xi, fig. 2.

|| *Ibid.*, pl. xi, fig. 5 *a*, *b*, p. 102.

P. westphalicum, Schlüter sp.,* and particularly the specimen figured by Grossouvre,† are close to the present example in ornamentation and general appearance, but the tubercles are coarser; on the other hand, in *P. tridorsatum*, Schlüter sp.,‡ and *P. moureti*, Grossouvre,§ costation is too fine and close.

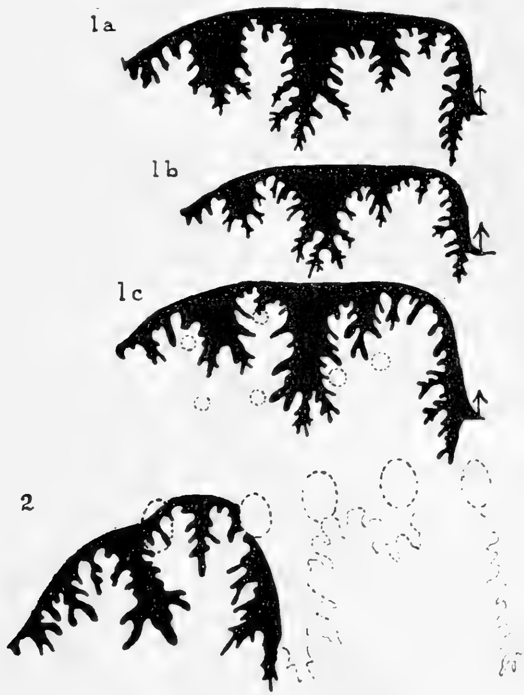

Fig. D.—1. *Mortoniceras stangeri*, Baily sp. Upper Senonian, Umtamvuna River, Natal. 1*a*. Specimen No. C19444, British Museum. 1*b*. No. C19443, comparable with Baily's co-type No. 11368A (Geol. Soc. Coll.). 1*c*. No. C19440 (penultimate septum of an example 340 mm. in diameter). Figs. 1 *a–c* are after drawings by the late G. C. Crick. 2. *Mortoniceras* aff. *umkwelanense*, Crick. Upper Senonian, Umkwelane Hill, Zululand. (Specimen No. 5491.) (P. 234). All reduced to $\frac{2}{3}$.

Since *Mortoniceras stangeri*, Baily sp., has tricarinate inner whorls, and has, indeed, been included in *Peroniceras* by some writers (*e.g.* Kossmat), the external suture-lines of three examples, drawn by the late G. C. Crick, and the internal portion of another example, showing

* *Loc. cit.* (1872), p. 45, pl. xiii, figs. 5 and 6.

† *Loc. cit.* (1894), p. 98, pl. xii, figs. 1 and 4, *a*, *b*.

‡ *Loc. cit.* (1876), pl. xli, figs. 3–5, 'Jüngst. Amm.' (1867), p. 26, pl. v, fig. 1.

§ *Loc. cit.* (1894), p. 100, pl. xi, figs. 3 and 4.

good agreement with Baily's type and one of Baily's co-types (11368A),* are here given for comparison (Pl. XXIII, fig. 3). The distinct second lateral lobe and independent second lateral saddle (on the umbilical wall) differ greatly from those of the specimen here described, though the whorl-section, at a diameter of about 25 mm., is that of a *Peroniceras.* At a stage corresponding to that of *Peroniceras* sp. ind. (in Redtenbacher: *A.* sp. indet. cfr. *A. tridorsatus,* Schlüter†), the costae of *M. stangeri* continue across the ventral area with its three faint keels, something after the style of the ventral area in *Pseudotropites ultraliasicus,* Canavari in Wähner.‡ If Baily's species is really of Upper Senonian age, as would appear from its association with *Hauericeras gardeni* and *Pseudophyllites indra,*§ it forms a striking case of convergence of a late *Mortoniceras,* characterised by its suture-line, towards the Lower Senonian *Peroniceras.*

P. dravidicum occurs, in India, in the Middle Trichinopoly group, which is considered to be of Coniacian (Lower Senonian) age. In Europe, *e. g.* the North of France,|| *Peroniceras subtricarinatum, westphalicum* and *moureti* occur in the zone of *Micraster cor-testudinarium.* Grossouvre¶ has all the species of *Peroniceras,* the exact horizon of which is known, in the Lower and Middle Coniacian. Boule, Lemoine and Thévenin** record what appears to be the Indian species from Madagascar; Solger describes it from the Cameroons.

Locality.—High ground on north side of United Manuan Creek and Umsinene River, almost opposite Junction. Coll. W. J. Wybergh. The mode of preservation of this specimen (limonite, after pyrites?) is different from that of any other Zululand Ammonite that the writer has examined.

* Baily's type of *A. stangeri* in the British Museum (Geol. Soc. Coll., No. 11366), a gigantic specimen of 325 mm. diameter, has the inner whorls corroded; the three co-types (11367, 11368 and 11368A) represent three slightly differing varieties, but the large series in the British Museum includes many transitions and shows the great variability of the species.

† *Loc. cit.* (1873), p. 125, pl. xxx, fig. 3.

‡ "Beitr. Kenntn. Tief. Zon. d. Unt. Lias N.Ö. Alp.," part vii, 'Beitr. Pal. Öst.-Ung.,' vol. ix (1894), pl. iii, fig. 1 *c* only.

§ According to Woods, *loc. cit.*, pp. 346–7. Two examples of *Pseudoschloenbachia umbulazi,* in the British Museum, from the Umtamvuna River, Pondoland, have impressions of large *Mortoniceras* of *stangeri* affinity, in the same pieces of matrix.

|| Pruvost, "Les Ammon. Sénon. d. Nord," 'Ann. Soc. Géol. Nord,' vol. xxxix (1910), pp. 365–8.

¶ *Loc. cit.* (1894), p. 106.

** *Loc. cit.* (1907), p. 42 (as "*Schloenbachia* (*Peroniceras*) *subtricarinatum* d'Orb."). See also Pervinquière, *loc. cit.* (1907), p. 250.

Gen. KOSSMATICERAS, de Grossouvre.

Sub-Gen. MADRASITES, Kilian & Reboul.

23. Kossmaticeras (Madrasites) bhavani, Stoliczka sp.

(Pl. XXIV, fig. 8.)

1865. *Am. bhavani*, Stoliczka. "Cret. Fauna S. India" (Pal. Indica), I. "Cephalopoda," p. 138, pl. lxix, figs. 4–7.

1897. *Holcodiscus bhavani*, Kossmat. "Unters. Südind. Kreidef.," Beitr. Pal. und Geol. Öst.-Ung., vol. xi, p. 38 (145), pl. viii (xix), figs. 5 and 6.

One example in the collection (No. 4909) agrees with the largest form figured by Stoliczka (fig. 6), and has the following dimensions:

Diameter	65 mm.
Height of the last whorl . .	40 per cent. of the diameter.
Umbilicus	29 ,, ,, ,,
Thickness of the last whorl . .	80 ,, ,, whorl-height.

Stoliczka's example has a whorl-height of 41 per cent., an umbilicus of 26 per cent. and a thickness of 77 per cent., so that it differs only in having a slightly narrower umbilicus; the umbilicus of the present example, in width, agrees more with that of the smaller form figured by Stoliczka. The inner whorls, shown in the umbilicus, are more distinctly costate than are those of either Stoliczka's or Kossmat's examples—possibly a matter of preservation.

The variety *densicostata*, Kilian and Reboul,* is much more finely ornamented than the form here described, as are, to a lesser extent, the slightly tuberculate var. *seymouriana*, Kilian and Reboul†, *K. (M.?) cumshewaense*, Whiteaves,‡ and the variety of the latter form figured as *Holcodiscus* cf. *H. theobaldianus*, Stoliczka, by Anderson.§ The writer has lately recognised the presence, in the Upper Senonian of New Zealand, of *Kossmaticeras (Madrasites) bhavani*, Stoliczka sp., and *K. (M.) cumshewaense* (? Whiteaves) Kilian and Reboul,‖ as well as of *K.* (*Gunnarites*) aff. *bhavaniforme*, Kilian and Reboul, *K.*

* *Loc. cit.* (1909), p. 30, pl. xviii, fig. 1, pl. xv, fig. 4.

† *Ibid.*, p. 29, pls. xiv, xv, xix.

‡ *Loc. cit.* ('Mesoz. Foss.,' 1884), p. 208, pl. xxiv, fig. 1.

§ *Loc. cit.* (1902), p. 101, pl. v, figs. 126–7. This form, however, is of Horsetown age, and Whiteaves' species also may be earlier.

‖ Possibly close to the incompletely known *K.* (*Madrasites*) *mcKayi*, Hector sp. ('Catal. New Zealand Court.' 1886, p. 57, text-fig. 19 *a*, No. 4) (misspelt *macCoyi* in Haug, "Traité," II, ii, p. 1345), that Steinmann (*loc. cit.*, 1895, p. 28) considered to belong probably to the group of *K.* (*M.*) *aemilianum*, Stoliczka sp.

(Grossouvrites) gemmatum, Huppé sp., and of *Pseudophyllites (Tetragonites?) sp. juv.**

The small *K. (Madrasites)* cf. *madrasinum*, Stoliczka sp., figured as *Holcodiscus* sp. by Woods,† from Pondoland, is distinguished by its pronounced umbilical tuberculation. The Madagascar form of *Kossmaticeras (Madrasites)* figured by Boule, Lemoine and Thévenin‡ as "*Holcodiscus theobaldinus*, Stoliczka sp. *var.*," differs from the form here described in having a larger umbilicus.

Crick described (in MS.) two species of *Kossmaticeras* from Pondoland as *Holcodiscus natalensis* and *H. acuticostatus*. He did not compare them with Woods' form, which is more involute, but stated that their nearest ally appeared to be *H. buddhaicus*, Kossmat—a statement with which the writer agrees. These two forms (B.M., No. C19432–3) differ little from each other, but are distinguished from the species here described by being evolute (U ≑ 34 per cent. and 37 per cent. respectively) and by having umbilical tubercles throughout. *K. (Madrasites) faku* and *K. (M.) africanum*, Hoepen sp., are closely similar forms§ represented in the collection from the Durban Museum.

Kilian has recorded *K. bhavani* also from New Caledonia,‖ and related forms occur throughout the Indo-Pacific province, whereas the European forms recorded as *Kossmaticeras* belong to other groups than the finely-ribbed South African *Madrasites*.

Locality.—South side of Manuan Creek Valley. Coll. W. J. Wybergh.

Gen. PLACENTICERAS, Meek.

24. Placenticeras cf. subkaffrarium, sp. nov.

Two whorl-fragments (Nos. 4957 and 4958), possibly belonging to the same individual, appear to be identical with the species described

* In collections kindly sent by Mr. Henry Woods, F.R.S., and by Dr. Trechmann (see 'Geol. Mag.,' n.s., dec. vi, vol. iv [1917], p. 338.)

† *Loc. cit.*, p. 336, pl. xlii, fig. 2. Kilian and Reboul (*loc. cit.*, p. 62) compare this form with the Antarctic *K. (Jacobites) anderssoni*. It may be near *K. (M.) africanum*, v. Hoepen sp.

‡ *Loc. cit.* (1906), p. 26 (vol. ii), pl. vii, fig. 3 (vol. i).

§ "Descr. of some Cret. Amm. from Pondoland," 'Ann. Transvaal Museum,' vol. vii, pt. ii (1920), p. 144, pl. xxv, figs. 3 and 4, and pl. xxvi, figs. 1 and **2**; p. 146, pl. xxvi, figs. 3–5.

‖ There is a specimen of a *Kossmaticeras (Madrasites) bhavani* (Stoliczka), var. *densicostata*, Kilian and Reboul, in the British Museum (No. C1536) from St. Vincent, West Coast (Bourail), New Caledonia.

from Umkwelane Hill (see p. 247), and the slight differences between the fragments themselves and the figured specimen (Pl. XXI, fig. 2) may be due to weathering. The ornament thus appears perhaps more distinct, after the style of *P. intercalare*, Meek, and the periphery may be just a trifle narrower. Like the type, these two examples differ from *P. tamulicum*, Blanford sp., chiefly in being fatter in the umbilical region. The suture-line is worn, but its plan agrees with that of the Indian species.*

Locality.—South side of Manuan Creek Valley. Coll. W. J. Wybergh.

NAUTILOIDEA.

Gen. CYMATOCERAS, Hyatt.

25. Cymatoceras? sp. cf. justum, Blanford sp.

1861. *Nautilus justus*, Blanford. "Cret. Fauna S. India" (Pal. Indica), vol. i, "Cephalop.," p. 22, pl. x, figs. 2–3.

? 1861. *Nautilus bouchardianus* (d'Orbigny) Blanford, pars. *Ibid.*, pl. iv, fig. 3 only.

1866. *Nautilus justus* (Blanford) Stoliczka. *Ibid.*, p. 206, pl. xciii, fig. 2.

1910. *Nautilus justus* (Blanford) Spengler, "Untersuch. ü. d. Südind. Kreideform., pt. iv, Die Nautil. und Bel. d. Trichinopoly Distr.," Beitr. z. Pal. und Geol. Öst.-Ung., vol. xxiii, pt. iii, p. 142, pl. xiv, fig. 3.

A small specimen (No. 4935) agrees with one of the examples described by Crick† as *Nautilus* (? *Eutrephoceras*) sp., both in whorl-shape and elegant ornamentation, as in the mode of preservation (brown limonite coating), but on account of its annular lobe and *elegans*-like (if fine) striation is referred to *Cymatoceras*. At a diameter of 40 mm. the whorl-thickness is 30 mm.; the siphuncle is centran and the umbilicus not quite closed.

Spengler thought Crick's *Nautilus* [*Cymatoceras*?] *occlusus* to be close to the species here discussed, but the latter is less globose. *Cymatoceras kossmati*, Spengler sp.,‡ agrees in whorl-shape, but the costation is much coarser, as it also is in the Utatur species *C. kayeanum*, Blanford sp.

* Fig. 1 *c* of pl. xxii, in Kossmat, *loc. cit.*, 1895.

† *Loc. cit.* (1907), p. 245, B.M., No. C18293.

‡ *Loc. cit.* (1910), p. 129 (*N. pseudo-elegans*, d'Orbigny in Blanford, *loc. cit.*, 1861, p. 33, pl. xviii, fig. 3).

This specimen is the only one in the collection from "High Ground, South Side of South Branch of Manuan Creek, just below Wagon-Drift." Coll. W. J. Wybergh. Its assumed Senonian age thus is not supported by Ammonite evidence, and its mode of preservation is distinct from that of any of the other specimens in this collection.

Observations on the Manuan Creek Fauna.

The relations of the Manuan Creek fauna have been discussed in detail by Crick and Newton, but it has been mentioned in the introductory part of this paper that the presence of Albian, Cenomanian and Lower and Upper Senonian forms was not clearly recognised, so that a revision of the faunas has become necessary. With regard to the Ammonoids, the few Senonian forms here described have already been referred to in the observations on the Umkwelane Hill fauna. They include the Coniacian—

Peroniceras cf. *dravidicum*, Kossmat sp.,

to which have to be added the two *Peroniceras* recorded by Crick, with the Cenomanian False Bay fauna, and here referred to on p. 296, namely:

Peroniceras cf. *czörnigi*, Redtenbacher, sp.

Peroniceras cf. *rousseauxi*, de Grossouvre.

To the presumably Campanian Ammonites described in this paper, namely,

Kossmaticeras (*Madrasites*) *bhavani*, Stoliczka sp.

Placenticeras cf. *subkaffrarium*, nov.

must be added the following forms described by Crick from the South Branch of the Manuan Creek:

Gaudryceras pulchrum, Crick.*

Gaudryceras cf. *kayei*, Forbes sp. [*Gaudryceras sp.* in Crick, p. 238.]

Diplomoceras? sp. [*Anisoceras sp.* in Crick, p. 239.]

Baculites cf. *capensis*, Woods [*Baculites sp.* in Crick, p. 240.]

Hauericeras sp.†

The Upper Senonian fauna of the Manuan Creek District thus shows a greater resemblance to the fauna of the Umzamba Group of Pondoland (so-called Umtamvuna Beds) than to the Umkwelane Hill fauna, which is much nearer, geographically, but which represents a different facies.

* *Gaudryceras* sp. (p. 239 in Crick) probably is a badly weathered fragment of this species.

† P. 242, pl. xv, fig. 5, the inner whorls erroneously being represented as having an acute venter. For *Hauericeras* sp. (p. 243), see above, under *Uhligella sp. n. cf. stoliczkai*, Kossmat sp. (p. 276, footnote †).

Acanthoceras sp. (in Crick, p. 241),

comparable with *A. latum*, Crick, and *A. quadratum*, Crick, is of Cenomanian age, like the "False Bay" fauna described by Crick. The resemblance of this fauna to that of Northern Africa on the one hand and India on the other was noticed by Pervinquière,* who thought it quite evident that inter-communication between these areas must have been easy.

There is, then, evidence in the Manuan Creek district of the presence of deposits of Albian, Cenomanian, Lower Senonian (Coniacian) and Upper Senonian (Campanian, incl. Maestrichtian?) age. The first of these formations, perhaps, is the most important, and of Crick's Manuan Creek Ammonites the following probably belong to it:

Phylloceras sp. (p. 236) [identical with *Ph. velledae*, Michelin sp., described in this paper].

Lytoceras crenulatum, Crick (p. 236).

Schloenbachia sp. (p. 240) [probably *Pseudophacoceras manuanense*, nov.].

Desmoceras sp. (p. 241) [*Latidorsella* ? sp. ind.].

"*Hauericeras*" sp. (p. 243) [probably *Uhligella* sp. n. cf. *stoliczkai*, Kossmat sp.].

A second specimen of a "*Hauericeras*"? sp. and a "? *Beudanticeras beudanti*" also probably belong to this last form, and other, unrecorded, specimens from the South Branch of the Manuan Creek in Crick's collection are:

Anisoceras sp.

Douvilleiceras sp.

"*Schloenbachia* aff. *delaruei*, d'Orbigny sp." [*Dipoloceras* sp.].

All the forms recorded by Crick from the Middle Tributary of the Manuan Creek, also, probably, are of Albian age, namely:

Puzosia concinna, Crick (p. 245).

Puzosia compacta, Crick (p. 246).

Schloenbachia sp. (p. 247) [*Dipoloceras* sp.].

Hysteroceras sp. (p. 248) [*Brancoceras* sp.].

These Albian forms allow of more exact correlation. Including those described by Etheridge from the Umsinene River (the types of which, however, the writer has not examined), the list of Albian Ammonoids, then, is as shown in Table I.

The forms mentioned in this list indicate that probably the Middle Albian (*mammillatum*, *delaruei*, and *cristatum* zones), and the Upper Albian, up to the upper *rostrata* zone above, are represented, the latter zone apparently transitional to the Lower Cenomanian, exposed near

* "Amm. d. Crét. Algér.," 'Mém. Soc. Géol. France,' Pal., vol. xvii, No. 42 (1910), p. 81.

Table I.—*Albian Ammonoidea from the Manuan Creek District.*

		Page.	Identical or allied species.	Europe.	Tunis.	Madagascar.	India.	Other countries.	Suggested horizon.	Remarks.
1. *Phylloceras velledae*, Michelin, sp.	M.	273	*P. velledae*	×	×	×	×	Conducia ?	(Albian)	Incl. *Phyll.*, sp. Crick, p. 236.
2. *Lytoceras crenulatum*, Crick.	S.	303	*L. mahadeva*, Stoliczka sp.	—	—	—	×	California ?	,,	Crick, p. 236.
3. *Puzosia* cf. *bhima*, Stoliczka sp.	M.	274	*P. bhima*	—	—	?	×	—	*rostrata* ?	—
4. ,, sp. (*Desmoceras* sp. Etheridge)	U.	276	*P.* of *planulata* group	—	—	×	×	—	(Albian)	Etheridge, p. 88.
5. ,, *concinna*, Crick.	M.	275	,,	—	—	—	?	—	,,	Crick, p. 245.
6. ,, *compacta*, Crick	M.	275	*P. octosulcata*, Sharpe sp.	×	?	?	?	—	,,	,, p. 246.
7. *Uhligella?* sp. n. aff. *stoliczkai*, Kossmat sp.	M.	275	"*A. beudanti*," Stoliczka	—	—	?	×	Persia	*rostrata* ?	Incl. *B.? beudanti* (Crick, in Coll.), and *Hauericeras*, sp. Crick, p. 243.
8. *Latidorsella?* sp. (*Desmoc.* sp., Crick)	S.	303	*Desmoceras inane* (Stol.)	—	—	—	×	—	(Albian ?)	Crick, p. 241.
9. *Douvilleiceras* sp. (Etheridge)	U.	220	*D. mammillatum* (Schloth.)	×	—	×	—	Angola	*mammillatum*	Etheridge, p. 87.
10. ,, sp. (Crick, in coll.)	S.	220	,,	×	—	—	—	Brazil	,,	Crick, in Coll.
11. *Dipoloceras cristatum*, Deluc sp.	C.	277	*D. cristatum* (Deluc)	×	×	—	—	Nigeria	*cristatum*	—
12. ,, *quadratum*, sp. nov.	M.	278	*A. bouchardianus* (Pictet)	×	×	×	—	,,	,,	—
13. ,, sp. nov.	M.	280	*Schloenbachia*, n. sp.	-	—	—	—	Mexico	,,	Böse, p. 74, pl. viii/6.
14. ,, sp. (*Schloenbachia*, Crick)	M.S.	220	*D. cristatum* (Deluc)	×	—	—	—	S. America	,,	Crick, p. 247, and Coll.
15. *Pseudophacoceras manuanense*, sp., nov.	C.	281	*P. multifidum* (Steinmann)	—	—	?	—	N. and S. America	,,	Incl. "*Sphenodiscus*, sp.," B.L.T and *Schloenbachia* sp., Crick, p. 240.
16. *Subschloenbachia prerostrata*, nov.	M.	284	*S. inflata*, auct.	×	?	×	—	—	*varicosum*	—
17. ,, cf. *trinodosa* (Böse)	V.	285	*S. trinodosa* (Böse)	×	?	?	?	Mexico	*rostrata*	—
18. ,, *bispinosa*, sp. nov.	M.	285	*S. inflata*, auct.	×	—	—	—	Queensland	*varicosum*	—
19. *Brancoceras* sp. (*Hysteroceras*, Crick)	M.	303	*B. varicosum*, auct.	×	×	×	—	—	,,	Crick, p. 248.
20. *Lyelliceras nodosum*, Etheridge sp.	U.	220	*L. lyelli* (Desh. in Leym.)	×	—	—	—	S. America	*cristatum* ?	Etheridge, p. 87.
21. *Stoliczkaia* sp. ind.	V.	286	*S. clavigera*, Neumayr	×	?	?	×	Angola, Texas	*rostrata*	—
22. *Torneutoceras* sp. ind.	V.	288	*Hamites virgulatus*, auct.	×	×	?	—	Angola	(Albian)	—
23 *Anisoceras* sp. ind.	L.	288	*Helicoc. thurmanni* (P. & C.)	×	—	?	?	—	*rostrata* ?	—
24. ,, sp.	S.	288	*Anisoceras alternatum* (M.)	×	?	?	?	—	,,	Crick, in Coll.
25. *Turrilites* cf. *gresslyi*, P. and C.	V.	289	*Turril. gresslyi*	×	?	×	?	Conducia ?	,,	—

M. = Middle Tributary of the Manuan Creek. S. = Southern Tributary of the Manuan Creek. C. = Manuan Creek. V. = South side of Manuan Creek Valley. U. = Umsinene River. L. = Isolated locality farther north.

the junction of the Umsinene River and the Manuan Creek. These horizons of the Upper and Upper Middle Albian, according to the succession tentatively suggested by the writer in his description of the Albian fauna of Angola, appear to be:

Upper *rostrata* horizon . .	"post-*rostrata*" (XIII, XII).*
Lower „ „	"*rostrata* s.s." (XI).
Upper *varicosum* horizon . .	"*prerostrata*" (X, IX *b*).
Lower „ „ . .	"*bouchardianum*" (IX *a*).
Upper *cristatum* „ . .	"*cristatum* s.s." (VIII).
Lower „ „ . .	"*cornutum*" (VII, VI).

It is to be hoped that further collecting will be done, with a view to tracing the succession of the Manuan Creek Albian in detail and elucidating the somewhat uncertain relations of, *e. g.*, the outcrop of the "Umsinene deposit," exposed chiefly in the bed of the southernmost tributary of the Manuan Creek† and apparently comprising Middle Albian and Campanian forms, with the neighbouring Coniacian and Cenomanian exposure near the junction of the Umsinene River and the Manuan Creek. It may be added that the forms of the highest Albian (upper *rostrata* zone, with *Stoliczkaia*) all come from one locality, namely the "south side of the Manuan Creek Valley" (V in the list), and that none of the other localities apparently have yielded examples that are referable to this highest Albian. In the case of the *Lytoceras* and the Desmoceratids (2, 3 and 7 in the list), the comparison with Indian species might suggest a high horizon in the Albian, only the top of this formation, apparently, being found in India; but the Ammonites probably are not specifically identical. On the other hand, it is just these forms that connect the Zululand fauna with the types special to the Indo-Malgascan Province, for nearly all the remaining Ammonites correspond with well-known European types, with the exception of *Pseudophacoceras manuanense* and of *Dipoloceras sp. nov.*, which are more closely comparable with American‡ species, and which, *e. g.* in Mexico, occur several hundred feet below the equivalent of the *rostrata* zone. The writer, in another place, when discussing the relations of the Angola fauna, referred to the probable immigration of these elements into the African region from South America along the southern edge of

* These numbers refer to the beds at Folkestone.

† Anderson, *loc. cit.* (Third Report, 1907), p. 58.

‡ Lemoine ('Pal. Nord. Madagascar,' 1906, pp. 204–5) recorded "*Schloenbachia roissyi* (= *Schl. acuto-carinata*, Shumard)" and "*S. mirapeliana*, d'Orbigny sp. (= *S. buarquiana*, White sp.)," but in the following year, Boule, Lemoine and Thévenin described a *S.* (*Mortoniceras*) cf. *inflatiformis*, Szajnocha, which probably is a *Subschloenbachia*, whereas their "Lower Cenomanian *Sphenodiscus*" may be a *Pseudophacoceras*, allied to *P. manuanense* and *P. buarquianum*.

the Africano-Brazilian Continent ("Brasilia"), whereas undoubtedly there also was free and direct communication through the Channel of Mozambique and the Sea to the North with the Mediterranean. That a larger number of forms are common to the European and the Zululand Albian, than to the latter, and *e.g.* the fauna of Tunis, probably is partly due to the fact that this formation has been much more thoroughly explored in Europe, and the Middle and Lower Upper Albian of North Africa, are still incompletely known.

It is interesting to note that the South Queensland forms of *Subschloenbachia*, described by Etheridge, are more closely allied to Zululand than to Indian forms; but since similar types occur again in Europe and in Mexico, perhaps no significance may be attached to this. Moreover, some of the Queensland forms appear to belong to the *prerostrata* horizon, which, probably, is not represented in Southern India, the lowest Utatur Beds, according to Kossmat, including *Stoliczkaia* and *Mantelliceras*, in addition to *Subschloenbachia*, and such forms as *Prohysteroceras propinquum* and *Neokentroceras* (gen. nov.*) *gracillimum*, Kossmat sp. On the other hand, *Dipoloceras* of the *cristatum* group, and *Subschloenbachia* have now been found in Nigeria, and the genera *Douvilleiceras*, *Subschloenbachia*, *Brancoceras* (?), *Stoliczkaia*, also *Desmoceratidae* and *Hamitidae* occur in Angola; yet, it may be held with Boule, Lemoine and Thévenin† that "the resemblances with West Africa (Angola) are feeble, and it seems . . . that West Africa formed part of another zoological province." This latter is characterised by the special genus *Elobiceras*‡ and the group of *Subschloenbachia evoluta*, nov., found only in Nigeria, the Elobi Islands, and Angola, possibly also in Tunis, whereas, as has been mentioned, the large *Lytoceras*, found again in Pacific regions, and certain Desmoceratids, connect the Zululand fauna with the special developments of the Indo-Malgascan Province. On the other hand, easy communication with the Mediterranean facilitated extensive faunal equalisation during the Aptian and Albian, extending to South America along the Northern§ and Southern shores of the Africano-

* A post-*Subschloenbachia* development (Genotype = *N. curvicornu*, nov. from Angola, allied to *N. tectorium*, White sp.).

† *Loc. cit.* (1907), p. 72.

‡ Gen. nov. (Genotype = *Schloenbachia elobiensis*, Szajnoçha, 1885, pl. iv, fig. 1). Described fully in the writer's Angola paper.

§ The westward extension of the Tethys is indicated by the close correspondence with European developments shown by the Upper Jurassic of Mexico, the Lower and Middle Cretaceous of Venezuela and Colombia, the "Gosau facies" of Jamaica and Mexico, etc. (see Suess, 'Face de la Terre,' vol. iii, pt iv, p. 1680). An arm of this sea reached south as far as Angola.

Brazilian Continent.* That the latter was still in existence in Upper Senonian times appears to be indicated by the extremely close resemblance of the *Kossmaticeras*-beds of Pondoland with those of Antarctica, Southern Patagonia, Chili and New Zealand, all of which are largely made up of glauconitic, calcareous sandstones, and apparently pass uninterruptedly into the lowest tertiaries.†

The lower Albian beds (Clansayes horizon) that bridge over the gap between the Aptian fauna of Powell's Camp and the *mammillatum*-zone of the "Umsinene River deposit," if present at all, have not yet yielded Ammonites.

IV. AMMONOIDEA FROM ISOLATED LOCALITIES.

A. North-West Shore of False Bay.

The present collection only includes two specimens from this locality (Coll. W. J. Wybergh) namely:

Mortoniceras vanuxemi, Morton sp.

Bostrychoceras? sp.

They are preserved in a brownish, marly sandstone, very friable, and thus different from the matrix of Crick's Cenomanian fauna, but this difference may partly be due to weathering. On the other hand, *M. vanuxemi* can definitely be dated as Campanian (zone of *M. delawarense*),‡ and the other specimen, as well, is comparable with a Pondoland form, considered by Woods to be of Campanian age. The outcrops of these beds along the north-western edge of False Bay are referred to by Mr. W. Anderson in the Second§ and Third Reports|| of the Geological Survey of Natal and Zululand. Crick¶ assumed that this was the locality from which the fossils were obtained that he described under the title of "The Cephalopoda from the Deposit at the North End of False Bay, Zululand." According to Mr. W. Anderson, however,** these Cenomanian Ammonites came from the river-bank near the

* Engler ("Üb. Florist. Verwandsch. zw. d. Trop. Afr. und Am., etc.," 'Sitz. K. Preuss. Ak. Wiss. Berlin,' 1905, i, p. 229) deduced the existence of large islands or a continent connecting Brazil with Africa from a study of the existing flora.

† See in O. Wilckens, "Die Kreideform. v. Neu-Seeland," 'Geol. Rundschau,' vol. xi (1920), pp. 189–91.

‡ Haug, 'Traité de Géologie,' II, ii, p. 1170.

§ 1904, p. 48.

|| 1907, p. 57.

¶ *Ibid.*, p. 164.

** 1907, p. 60. See also Crick ('Geol. Mag.,' August, 1907), p. 344.

junction of the Manuan and Umsinene Rivers, whereas from the western bank of False Bay he only "obtained some fragmentary fossils, very badly preserved, which Mr. Etheridge was inclined to think belonged rather to the Tertiary than to the Cretaceous System."*

Gen. MORTONICERAS, Meek.

1. Mortoniceras vanuxemi, Morton sp.

(Pl. XXIII, figs. 4*a*, *b*.)

1892. *Mortoniceras vanuxemi* (Morton), Whitfield. "Gast. and Ceph. Raritan Clays," Mon. U.S. Geol. Surv., vol. xviii, p. 252, pl. xlii, figs. 3–4.

1907. *Mortoniceras delawarense* (Morton), Stuart Weller. Rep. Cret. Pal. New Jersey, vol. iv, Pal. Ser., p. 837, pl. civ, figs. 4–5 only, *non* pl. ciii.

A fragmentary specimen (No. 4947), showing interlocking suture-lines and an impression of portions of the inner whorls, agrees with the above figures and undoubtedly belongs to this species, which is distinguished from its close ally *M. delawarense*, Morton sp., by being more compressed and less coarsely ornamented. The suture-line is of the same type as those of *M. woodsi* (Pl. XXI, fig. 1 *c*) and *M. soutoni* (Baily) (Pl. XX, fig. 4) figured in this paper, but differs in the terminal branches of the lateral lobe, which is perhaps due to the interlocking of the (last few ?) suture-lines.

M. woodsi, nov., is an extreme development of *M. vanuxemi*, with overhanging umbilical edge and fine and close ornament.

Gen. BOSTRYCHOCERAS, Hyatt.

2. Bostrychoceras, ? sp.

1906. *Heteroceras* sp., Woods. "Cret. Fauna of Pondoland." Ann. S. Afr. Mus., vol. iv, pt. vii, No. xii, p. 339, pl. xlii, fig. 4.

A small fragment (No. 4952), about 28 mm. in length, belongs to the form described by Woods and has four intermediate ribs between the flares, but it is too fragmentary to determine whorl-shape and coiling. The reasons for referring the form to *Bostrychoceras* are discussed under *B. ?* sp. nov. (p. 252) of the Umkwelane Hill fauna. *Hamites* sp., described and figured by Jimbo,† seems to belong to a

* *Ibid.*, p. 57.

† *Loc. cit.*, p. 40, pl. ix, fig. 1 only.

similar form. Woods noted the resemblance of this form to *Hyphantoceras reussianum*, d'Orbigny sp.; *H. flexuosum*, Schlüter sp.,* and *H.* sp. nov. (= *Heteroceras* sp. in Woods),† are other species of the genus *Hyphantoceras* that show superficial resemblance, but are of Turonian age.

The example is distinguished from the *B.? sp. ind.*, found at Umkwelane Hill (p. 255), by having coarser costation and four, not three, intermediate ribs, so that at a similar whorl-height the flares are about twice as far apart in the present form.

B. POWELL'S CAMP, UPPER CATEMBE, PORTUGUESE EAST AFRICA.‡

The three Ammonites from this locality (Nos. 5117–19) are preserved, as casts, in a light yellowish-grey, calcareous sandstone, and two of them show portions of the test. This matrix, stained yellow with rust in places, is not unlike the lighter-coloured portions of the calcareous sandstones of Umkwelane Hill, and apparently is similar to that of the Aptian fauna of Delagoa Bay, recorded by Kilian§ and described by Krenkel.||

The three forms described below are—

Aconeceras nisoides, Sarasin sp.

Cheloniceras gottschei, Kilian sp.

Cheloniceras (*Acanthoplites*?) *delagoense*, Krenkel sp.

The assemblage, thus, is the same as that recorded from Delagoa Bay, of the same sandy, littoral facies, and undoubtedly of Aptian age. Dr. Kitchin¶ has already referred to this Aptian fauna from Delagoa Bay in his important memoir on the Uitenhage Beds.

Krenkel was of opinion that the Bedoulian (Lower Aptian) as well

* *Loc. cit.*, p. 108, pl. xxxii, figs. 10–12.

† 'Q.J.G.S.,' vol. lii (1896), p. 75, pl. ii, figs. 7 and 8.

‡ When writing this account, the author was under the impression that Powell's Camp was in Zululand, but it now appears that though its exact position and the meaning of "Upper Catembe" are unknown, it may be in the neighbourhood of Delagoa Bay, Catembe being marked on Jeppe's map as being on the right bank of the Tembe river, some five miles from the mouth.

§ "Üb. Aptian in S. Afr.," 'Centralbl. f. Min.,' August, 1902, p. 465; also 'Bull. Soc. Géol. France' (4), II, 1902, p. 358; and 'Comptes Rendus,' cxxxv, No. 1, (July 1902), pp. 68–71.

|| "D. Aptfossil. d. Delagoa Bai," 'N. Jb.f. Min., etc.,' 1910 (I), pp. 142–168, pl. xvii.

¶ "The Invertebr. Fauna and Pal. Rel. of the Uitenhage Ss.," 'Ann. S. Afr. Mus.,' VII, pt. ii, No. 3 (1908), p. 57.

as the Gargasian (Upper Aptian) were represented in the Delagoa Bay fauna, and he considered "*Oppelia*" *nisus* (d'Orbigny) to be a typical representative of the latter division. Haug* has a zone of "*Oppelia*" *nisus* above the zone of "*Parahoplites*" *deshayesi* and *Ancyloceras matheronianum*, which includes the whole of the Bedoulian, but v. Koenen† records "*Oppelia*" *nisoides*, indistinguishable from the example here described, from the zone of "*Parahoplites*" *weissi*, which constitutes his lowest Aptian, below the *deshayesi* zone. Kilian‡ considered that the occurrence of *Aconeceras nisum* in the Upper Aptian (Gargasian) of the South of France indicated a migration of this genus from north to south, but it seems to the writer that the range in the Aptian of this form and of its close allies, like *A. nisoides*, is not yet known.§

It has to be noted in this connection that the suture-lines of the two forms of *Cheloniceras* agree with that of *Ch. cornuelianum* (d'Orbigny) much more than with those of the *Acanthoplites* of the *bigoureti* group; and *Ch. cornuelianum* is put into the Lower Aptian both by Kilian|| and by R. Douvillé,¶ whereas, according to Haug,** at la Bedoule, *Ch. cornuelianum* occurs both in the lower Aptian, *i. e.* in the true Bedoulian, and in the higher division (Gargasian), and it is associated with "*Oppelia*" *nisus* also at other localities.††

The relations of the Delagoa Bay fauna with those of other parts of Africa, of Madagascar, India, etc., were ably discussed by Krenkel in the paper quoted above, and in another memoir on the Lower Cretaceous of East Africa.‡‡ Zwietzycki§§ later described a fauna, from doubtful localities in East Africa, that included *Acanthoplites* (?) *rauffi*, Zwietzycki sp., and *Diadochoceras nodosocostatum*, d'Orbigny sp. The former is compared with *Cheloniceras cornuelianum*, and only differs from the example here described as *Ch. gottschei* in retaining bituberculation to a larger diameter; but it probably is an *Acanthoplites* of the

* Traité, II, ii, p. 1170.

† "Amm. d. Nordd. Neoc.," 'Abh. K. Pr. Geol. L.A.,' N.F., Heft. 24 (1902), p. 51.

‡ In Lethaea Geogn. II, Mesoz. 3, Kreide, I, 3, 1913, p. 338.

§ In his latest paper ('Trav. Lab. Géol. Univ. Grenoble,' vol. xii [1919], p. 94), Kilian has *A. nisoides* as Gargasian.

|| *Loc. cit.* (1910), p. 281.

¶ 'Pal. Univers.,' 1911, No. 209.

** *Loc. cit.*, p. 1198.

†† *E.g.* pp. 1183, 1191, *loc. cit.* (Haug).

‡‡ 'Beitr. Pal. Öst.-Ung.,' vol. xxiii (1910), pp. 230–250.

§§ "D. Ceph. d. Tendaguru-Sch. i. Deutsch. O. Afr.," 'Wiss. Erg. d. Tendag. Exp., 1909–12,' pt. iii, 'Arch. f. Biontol.,' 1914, vol. iii, pt. 4.

lower Clansayes horizon = Zone III in Jacob.* Kilian† also puts this horizon as the base of the Albian, but Haug‡ has the Clansayes Beds (= "zone of *D. nodosocostatum*") as the uppermost Aptian. At any rate, this East African fauna described by Zwietzycki includes higher horizons than do the Aptian faunas of Delagoa Bay and of the present locality.

If the latter come from one horizon, then it is probable that this corresponds with what is called the *furcatus*-zone (?) in the table below. Stolley§, probably wrongly, quoted *Ch. cornuelianum* from his "Middle Gault" zone 1, which misled the writer when drawing up the correlation notes, kindly inserted by Mr. L. Dudley Stamp in the "Report of Excursion to Tilburstow Hill and Nutfield."|| The correlation with Stolley's horizons of the Upper Aptian, therefore, has here been corrected:

Upper Albian	Hor. IX–XIII (Folkestone) (Upper Gault)	Hor. 7 (Stolley)	VI (Jacob).
Middle Albian	Hor. I–VIII (Folkestone) (Lower Gault) '*mammillatum* bed.'	,, 6	V
Lower Albian	*tardefurcata* z. *regularis* subz.,	,, 5	IV
	milletian. ,,	,, 4	
	nodosocostat. z. *jacobi* ,,	,, 2	III
	nolani ,,	,, 1	
Upper Aptian (Gargasian)	*subnodosocostatum* z.	,, 5	IIb
	furcatus z. (?)	,, 4	IIa
Lower Aptian (Bedoulian)	*deshayesi* z.	,, 3	I
	weissi z.	,, 2	
	bodei z.	,, 1	

Gen. ACONECERAS, Hyatt, 1903.

1. Aconeceras nisoides, Sarasin sp.

(Pl. XXVI, figs. 4 *a*, *b*, text-fig. B 9, p. 241.)

1893. *Oppelia nisoides*, Sarasin. "Étude s. l. *Oppelia*, etc.," Bull. Soc. Géol. France (3), vol. xxi, p. 155, pls. iv–vi, figs. 10 *a–c*, text-figs. 3 and 5 (p. 154).

1902. *Oppelia nisoides*, Sarasin. V. Koenen, "Amm. d. Nordd. Neocom.," Abh. K. Pr. Geol. L. A., N.F., Heft 24, p. 51, pl. xlv, figs. 2 and 3.

* *Loc. cit.* (1907), pp. 296–306.

† *Loc. cit.* (1913), p. 341.

‡ 'Traité,' p. 1199.

§ "Die Glied. d. Nordd. Unt. Kreide," 'Centralblatt f. Min.,' 1908, p. 242.

|| 'Proc. Geol. Assoc.,' 1921, vol. xxxii, pt. 1, pp. 30–32.

1913. *Adolphia nisoides*, Kilian. "Lethaea Geognostica. II, Mesoz.," 3, I, 'Unterkreide,' fasc. 3, pp. 337–8.

A completely septate specimen (No. 5119), with the suture-lines well shown, has the following dimensions:

Diameter	39·5 mm.
Height of last whorl . .	53 per cent. of the diameter
Thickness ,, ,, . .	23 ,, ,, ,,
Umbilicus	11 ,, ,, ,,

Being a cast and slightly worn, the specimen has the fine ornament, which distinguishes the species from *A. nisum*, d'Orbigny sp., only preserved in one or two places, and near the umbilicus, but there is very good agreement in all characters with Sarasin's type. Krenkel's* Delagoa Bay specimen (*Oppelia nisus*) agrees with the present example in smoothness and in whorl-section.

The hollow keel is the important distinguishing feature of this form from the flat and smooth examples of *Pseudoschloenbachia*, e. g. *P. griesbachi*, Crick (M.S.) sp.† which have a very similar suture-line (compare figs. B8 and B9, p. 241), but less parallel sides, and which are of Senonian age.

Hyatt's genus *Aconeceras*‡ has priority before Stolley's *Adolphia*,§ and Hyatt may have been right in assigning this genus to *Desmoceratidæ.* It probably has nothing to do with *Oppelidæ.*

Gen. CHELONICERAS, Hyatt, 1903.

2. Cheloniceras gottschei, Kilian sp.

(Pl. XXVI, figs. 1 *a–d.*)

1902. *Acanthoceras (Parahoplites) martini*, d'Orbigny sp., var. *gottschei*. Kilian, "Apt. i. Südafr.," Centralbl. f. Min., etc., p. 465.

1910. *Douvilleiceras martini*, var. *gottschei*, Kilian. Krenkel, "Aptfoss. d. Delagoa Bai," N. Jb. f. Min., etc. (I), p. 144, pl. xvii, figs. 4, 5, 8, 9.

* *Loc. cit.*, p. 142, pl. xvii, figs. 1 *a* and *b*, and p. 164.

† = *A. umbolazi*, Griesbach ('Q.J.G.S.,' vol. xxvii [1871], p. 63, pl. iii, fig. 1), *non A. umbulazi* Baily (B.M., No. C19428), a smooth form of 103 mm. diameter, with the greatest whorl thickness at the middle of the side, not near the umbilical border, as in *A. umbulazi*, typus; with umbilical tubercles, but no costation, and with faint constrictions, like *P. papillata*, G. C. Crick (M.S.) sp.

‡ 'Pseudoceratites,' 1903, p. 100.

§ "Üb. Nordd. Æquival. Clansayes Fauna, etc.," 'Centralbl. f. Min.,' 1907, p. 269 (foot-note).

A specimen (No. 5117) of 72 mm. diameter, with only the body-chamber portion (occupying three-quarters of a whorl) well preserved, and with the inner whorls largely replaced by crystalline calcite, has the following proportions:

Height of the last whorl	.	38 per cent. of the diameter
Thickness ,, ,,	.	47 ,, ,, ,,
Umbilicus . . .	.	35 ,, ,, ,,

The coronatiform innermost whorls (diameter = 4 mm.) have a depressed whorl-section with prominent lateral spines and constrictions, like the ammonite next described, and like *Cheloniceras royerianum*, d'Orbigny sp. The following stage, represented by Krenkel's figures, and comparable with Sinzow's examples of *Ch. seminodosum* (Sinzow) and *Ch. meyendorffi* (d'Orbigny),* is badly preserved. Only the first prominent rib, at the beginning of the well-preserved body-chamber portion, has a lateral tubercle, in addition to the umbilical one, so that there is loss of the characteristic bituberculation, as stated by Krenkel, and as shown in the specimen of "*D. cornuelianum*" figured by Kilian.† The latter, however, has lost the umbilical tubercle, as well as the lateral one, whereas in the form here described this umbilical tubercle remains distinct on some of the longer ribs, which feature approaches the present example to *Ch. albrechti-austriae* (Hohenegger), Sinzow sp.,‡ to *Ch. tschernyschewi*, var. *laticosta*, Sinzow sp.,§ and to other forms of the *cornuelianum* group.||

On account of the imperfect condition of the present example,¶ identification with Kilian's form, or with any of the other species of the *cornuelianum* group, is, perhaps, impossible, but though *Ch. gottschei* was only figured in small examples, it appears probable that the present specimen represents the adult stage of that form, showing "decline" of the costation, as does *Ch. meyendorffi* (d'Orbigny) in Sinzow.** The present example, at any rate, is closer to the

* "Beschr. einiger *Douvilleiceras*-Arten a. d. Ob. Neocom. Russl.," 'Verh. Russ. Kais. Min. Ges.' (ser. 2), vol. xliv (1906), pl. i, figs. 6 and 8.

† *Loc. cit.* (1913), p. 339, pl. ix, fig. 3.

‡ *Loc. cit.* (1906), pl. iv, figs. 1 and 2, and Kilian, *loc. cit.* (1913), pl. viii, fig. 2.

§ *Ibid.*, p. 187, pl. iii, fig. 1, and Kilian, *loc. cit.* (1913), p. 340, pl. ix, fig. 5.

|| A specimen in the British Museum (No. 46590), from the Isle of Wight, is almost indistinguishable from the present form in ornament and suture-line, but the whorl-section increases more rapidly in width.

¶ The restoration of the inner whorl, given in fig. 1 *c*, is somewhat problematical. Only two or three ribs are shown (on one side only), and of these one has the inner, the other only the outer, tubercle preserved.

** *Loc. cit.* (1906), pl. i, fig. 8.

Delagoa Bay form than is Kilian's "*D. cornuelianum*," cited above, to the specimens of the same species figured by Sinzow.*

Kilian † put "*D.*" *martini*, var. *gottschei*, into the group of "*D.*" *martini*, but if the present specimen is correctly identified with Krenkel's Ammonites, the character of the outer whorl and the suture-line approach the South African form more to the *cornuelianum* group. The writer, therefore, has raised this variety to an independent species. There is no differentiation of the peripheral area as there is in the *martini* group, *e. g.* in "*D.*" *martini*, var. *orientalis*, Jacob.‡

Ch. kiliani, v. Koenen sp.,§ differs in suture-line, but is close to the South African form as regards costation. The lateral tubercle, however, persists on some of the ribs in v. Koenen's species, and the whorl-section is less depressed.

The suture-line (only the last one or two are visible, in addition to the immature ones at a diameter of 4 mm.) is characterised by a high external saddle and a very wide lateral saddle. The leaflets subdividing the equally wide lateral lobe are unusually large, and there is good agreement with the suture-lines of *Ch. cornuelianum* and *Ch. meyendorffi* (d'Orbigny) in Sinzow.‖ This type of suture-line distinguishes the form here described from the somewhat similar *Acanthoplites* of the *aschiltaensis-bigoureti-bergeroni* group ¶ of a higher horizon, but it is interesting to note that in a still later group, namely that of *Acanthoceras giltairei*, Pervinquière ** and *A. euomphalus* (Sharpe),†† this wide lateral lobe with its prominent, median saddle ‡‡

* *Ibid.*, pl. i, figs. 1 and 2.

† *Loc. cit.* (1913), p. 340.

‡ In Jacob and Tobler, "Gault de la Vallée de l'Engelberger Aa," 'Mém. Soc. Pal. Suisse,' vol. xxxiii (1906), pl. i, figs. 1–3.

§ *Loc. cit.* (1902), p. 406, pl. xxxiii, figs. 1 *a* and *b*.

‖ *Loc. cit.*, text-figs. 1 and 2, pp. 160 and 164.

¶ See Seunes, "Amm. du Gault," 'Bull. Soc. Géol. France' (3), xv (1887), pls. xii–xiv; and Anthula, "Kreidefoss. d. Kaukasus," 'Beitr. Pal. Öst.-Ung.,' xii (1899), pls. ix–xiii.

** *Cf. loc. cit.* (1907), text-fig. 108 on p. 286.

†† "Foss. Moll. Chalk," 'Mon. Pal. Soc.,' II (1854), p. 31, pl. xiii, figs. 4 *a–c*.

‡‡ See Crick, "Note on *A. euomphalus*," 'Geol. Mag.,' N.S., dec. iv, vol. vi (1899), pp. 252–3. A specimen of this rare species in the writer's collection has the lateral saddle rather larger than the saddle subdividing the lateral lobe, which, in Crick's figures, might be mistaken for the former. Sharpe's fig. 4 *c* represents the relative sizes more accurately. This type of suture-line is a development of that of *Acanthoceras cunningtoni*, Sharpe sp., and of *A. sussexiense*, Mantell sp. (Sharpe, *loc. cit.*, pl. xv, figs. 1 *d* and 2 *c*), and the resemblance to *Douvilleiceratidæ* is a case of convergence.

is found again. The inner whorls of the present example, however, show that the resemblance with certain Acanthoceratids, notably *Calycoceras naviculare*, Mantell sp.* is quite superficial.

The Persian example of "*Acanthoceras cornueli*" recorded by H. Douvillé† is much more coarsely costate than the specimen here described.

The very large *Douvilleiceras*, referred to on pp. 220 and 303 as coming from the South Branch of the Manuan Creek, belongs to a different group of forms. It somewhat resembles the large (and more rapidly increasing) "*Pachydiscus*" *Waageni*, Anthula,‡ in its closely costate outer whorl, but appears to be a development of the Albian *mammillatum* group (as far as can be judged by the poorly preserved younger whorls), and possibly is a very large example of the form figured by Etheridge.§ It does not appear to have anything to do with the Aptian form here described.

* Also recorded from Madagascar, though the two forms figured by Boule, Lemoine and Thévenin (*loc. cit.*, 1907, p. 30, pl. viii, figs. 1 and 2) are very doubtful. Fig. 2 may be a *Mantelliceras*, with smooth ventral area on the inner whorls, whereas *Calycoceras*, which is a post-*Metacanthoplites* stock, has a median row of tubercles in the young. In *Calycoceras gentoni* (Brongniart = Sharpe's figs. 3 and 5, pl. xviii) all the ventral tubercles disappear at about the same time ('Pal. Univ.,' 1911, No. 223); in *C. naviculare*, Mantell sp. (lectotype, Sharpe's figs. 1 and 8, pl. xviii (B.M. No. 36834), Mantell's original being useless), the two ventro-lateral rows persist longer than the median row. Mantell's type, refigured in a posthumous paper by Crick ("*A. navicularis*, Mantell," 'Proc. Mal. Soc.,' vol. xiii, 1919, pp. 154–160, pl. iv) is too worn and scraped about to show any tubercles, and the writer believes that what Crick (p. 157) had considered as differences of specific value cannot be relied on, some of the ribs being artificially carved, or at least scraped, and the original shape of the whorl is quite unrecognisable. The resemblance to the Indian and Portuguese forms, which are very tumid-whorled, and to d'Orbigny's figure may not be so great as appears from a comparison of the figures, and in India, as in the English Chalk, a number of undescribed forms of *Calycoceras* occur; for Stoliczka (p. 74) states that "there are specimens which have scarcely any trace of either lateral or dorsal tubercles, even in the youngest stages," *i. e.* forms near to *C. baylei*, Pervinquière (= *A. sarthacense*, Bayle). Peron and Pervinquière had drawn attention to the similarity between *Calycoceras* of the Cenomanian and the Turonian *Fagesia*. Crick (in coll.) had labelled Mantell's type "*Fagesia navicularis*," but since he did not refer to this genus in his last paper, he probably came to the conclusion that the specimen, after all, was a Cenomanian "*Acanthoceras*," as he did in his earlier work on the False Bay fauna (p. 205).

† "Mission Scientif. Perse, Morgan," vol. iii, "Et. Geol.," pt. iv, 'Pal.,' 1904, p. 231, pl. xxviii, figs. 1 *a*, *b*.

‡ *Loc. cit.*, p. 106, pl. ix, figs. 1 *a*, *b*, Sinzow (*loc. cit.*, 1906), p. 164, pl. i, fig. 10 (as *Douvilleiceras meyendorffi*, var. *waageni*).

§ *Loc. cit.* (Third Report), pl. v, fig. 1. There also is a resemblance to Choffat's *Acanthoceras marques-costai* ('Conducia,' 1903, p. 27, pl. vii, fig. 2), but this form is compared with Cenomanian Ammonites.

Hyatt's genus *Cheloniceras* is adopted for these Aptian forms since the genus *Douvilleiceras* should be restricted to the Albian *mammillatum* group. According to Kilian* the group of "*Douvilleiceras*" *royerianum*, d'Orbigny sp. (= type of *Cheloniceras*), is closely connected with the *martini* and *albrechti-austriae* groups (to which last the form here described belongs), and not with the group of "*D.*" *bigoureti*, which "leads to *Acanthoplites*." The relations of these Aptian forms with the Barremian *Paraspiticeras* have yet to be worked out. Sinzow† would include the type of *Paraspiticeras* (*P. percevali*, Uhlig sp.) with the Aptian *Ch. meyendorffi*, d'Orbigny sp.,‡ but in the writer's opinion the two developments are distinct.

3. Cheloniceras (Acanthoplites ?) delagoense, Krenkel sp. (Pl. XXVI, figs. 2 *a–d*.)

1910. *Douvilleiceras delagoense*, Krenkel. "Aptfossil. d. Delagoa Bai," N. Jb. f. Min., etc. (i), p. 147, pl. xvii, figs. 6 and 7.

A small example (No. 5118), showing very good agreement with Krenkel's species, by its suture-line belongs to the same group of forms as the specimen last described, but in loss of tuberculation, and in the costation of the outer whorl, one-third of which already belongs to the body-chamber, it has a superficial resemblance to the genus *Acanthoplites*. The dimensions are as follows:

Diameter . . .	22 mm.
Height of the last whorl .	37 per cent. of the diameter.
Thickness ,, ,,	48 ,, ,, ,,
Umbilicus . . .	40 ,, ,, ,,

At a diameter of 7·5 mm., at which the suture-line represented in fig. 2 *c* was taken, the whorl-section is depressed, and there are constrictions as in *Cheloniceras royerianum*, d'Orbigny sp., and in the specimen last described. The point of bifurcation of the ribs is marked by a tubercle at this stage, as in *Cheloniceras seminodosum*, Sinzow sp.,§ or in *Acanthoplites Bigoureti* (Seunes), Jacob,‖ and the

* *Loc. cit.* (1913), p. 340.

† *Loc. cit.* (1906), p. 163.

‡ See also 'Pal. Univ.,' 1911, pl. ccix.

§ "Beschr. einiger *Douvilleiceras*-Arten a. d. Ob. Neocom. Russl.," 'Verh. Russ. Kais. Mineral. Ges.' (2), vol. xliv (1906), p. 165, pl. i, fig. 3 only.

‖ "Gisement de Clansayes," 'Bull. Soc. Géol. France' (4), v, pl. xiii, figs. 6 *a*, *b*.

intermediate ribs also may have a tubercle at this point, even when single, giving the inner whorls a coronate appearance. After a diameter of 10 mm., however, all tuberculation is lost, whereas Krenkel's type shows the last tubercle only at a diameter of 15 mm. This loss of tuberculation is a feature found in certain varieties of "*D.*" *tschernyschewi*, Sinzow,* but much more typically shown in certain *Acanthoplites*. *A. bigoti* (Seunes), Sinzow sp.,† *e.g.*, has a very similar outer whorl; and the suture-lines of this form, and of *A. bigoureti*, Seunes sp., as figured by Jacob,‡ are not very different from that of the present specimen. Seunes's type,§ however, and the form figured by Pervinquière,‖ are less closely comparable. On the other hand, the small example of *Ch. seminodosum*, the lateral and peripheral views of which, as figured by Sinzow, greatly resemble the (somewhat less depressed) South African form, instead of losing the original tubercle, takes on a second one, that is to say, it becomes a more closely costate type of *Ch. cornuelianum*.

The suture-line corresponds with that found in certain *Acanthoplites*, *i.e.* the *bigoureti-bergeroni* group, and with that of the *cornuelianum-meyendorffi* group, referred to above; also with that of *Ch. hambrovii*, Forbes sp.¶ Those of the typical *Acanthoplites* (*aschiltaensis* group)** and of the true *Parahoplites* (*melchioris*-group)†† are different.

There is no close resemblance to any of the various forms of the South American Aptian (e.g. *A. roseanus*, *treffryanus*, Karsten sp.‡‡), of which there is a large series in the British Museum, and which (with forms like d'Orbigny's *A. crassicostatus*,§§ with *A. peltoceroides*,

* *Loc. cit.*, *e.g.* pl. iii, fig. 4.

† "Unters. einiger Amm. a. d. Unt. Gault Mangyschlaks und d. Kaukasus," 'Verh. Russ. Kais. Min. Ges.,' ser. 2, vol. xlv (1907), pl. iv, fig. 18.

‡ *Loc. cit.* (Clansayes), p. 412, fig. 5; p. 415, fig. 7.

§ *Loc. cit.* (1887), pl. xii, fig. 2, p. 568.

‖ *Loc. cit.* (1907), pl. vii, figs. 36 *a*, *b*.

¶ See fig. 3, pl. viii, taken at a diameter of 10 mm., from an Isle of Wight specimen in the writer's collection.

** In Sinzow, *loc. cit.* (1907), pl. v, *e.g.* figs. 1 and 3; also Anthula, *loc. cit.* (1899), pl. x, fig. 3 *b*.

†† In Sinzow, *loc. cit.* (1907), pl. ii, figs. 1–4; also Anthula, *loc. cit.* (1899), pl. viii, fig. 4 *c*.

‡‡ "Üb. d. Geogn. Verh. d. Westl. Columb., etc.," 'Amtl. Ber. 32. Vers. Deutsch. Nat. F., etc.,' Vienna, 1858, *e.g.* pl. ii, fig. 4; also Lea, "Notice of Ool. Form. i. Am.," 'Trans. Am. Phil. Soc.,' Philad. (vii), N.S., 1840–1, pl. viii, figs. 4, 5.

§§ *Loc. cit.* (1840), pl. lix, figs. 1–4.

Kilian *non* Pavlow sp.,* *A. tobleri,* Jacob sp.,† and Sinzow's various Caucasian *Acanthoplites*‡) show the peculiar ventral flattening of the costation that is only just indicated in Krenkel's species. The *Acanthoplites* of the *milletianus-jacobi* group found in North Germany (Schrammen, Collet, etc., Colls., British Museum) belong to a different group again. On the other hand, there is a superficial resemblance to certain *Calycoceras* of the Cenomanian, notably to *C. baylei,* Pervinquière, or to the form figured by Vilanova.§

Kilian‖ first named this species *Acanthoceras* (*Parahoplites*) *abichi* (Anthula) var. *africana,* but Krenkel drew attention to the differences between the African and the Caucasian forms. The suture-line confirms this separation of *Ch. delagoense* from *Acanthoplites abichi,* which latter belongs to the *bergeroni-bigoureti* group, and was, indeed, united with the last species by Pervinquière.¶

The genus *Paraspiticeras,* which shows a change to costation, following on tuberculation, does not have the slightly sigmoidal ribbing which approaches the present example so much to the inner whorls of the *Acanthoplites bigoti* figured by Sinzow (1907) on pl. iv, fig. 18.

EXPLANATION OF PLATES XIX—XXVI.

PLATE XIX.

FIG.

1. *Diaziceras tissotiaeforme,* gen. and sp. nov. Upper Senonian, Umkwelane Hill. Specimen No. 5478, p. 245. *a.* Side view of holotype. *b.* Peripheral view, not quite central. *c.* Sectional outline, at diameter = 50 mm. *d.* Inner whorls, at diameter = 3 mm., × 15. The keel appears at a diameter of about 2·5 mm. *e.* Adult suture-line, × 2, external portion. *f.* Internal portion of same. *g–k.* Development of suture-line, at diameters of 1·5 mm. (*g*); 2 mm. (*h*); 3 mm. (*i*); 5·5 mm. (*j*); 8 mm. (*k*). All greatly magnified.
2. *Parapuzosia* sp. nov. ? ind. Upper (?) Senonian, Railway Cutting, Umfolozi. Specimen No. 5513, p. 224. Reduced about $\frac{1}{7}$. After a photograph sent by Dr. A. L. du Toit.

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* Pavlow's form ('Argiles de Speeton,' 1892, p. 152, pl. xi, figs. 20 and 21), according to specimens in the British Museum and information kindly given by Mr. Lamplugh, does not belong to this family and formation.

† *Loc. cit.* ('Engelberger Aa,' 1906), p. 11, pl. ii, figs. 4–6 (*Parahoplites*).

‡ *Loc. cit.* (1907), pl. v.

§ 'Mem. Geogn. d. Castellon,' pl. ii, fig. 5 (as *A. mantelli*). The *A. cornuelianus* (*ibid.*, fig. 11) of this author is considered by Kilian (1913, p. 341) to belong, probably, to *Ch. albrechti-austriae,* Hohenegger sp.

‖ *Loc. cit.* (1902), p. 465.

¶ *Loc. cit.* (1907), p. 195.

PLATE XX.

FIG.

1. *Parapuzosia*, sp. nov ? ind. (Specimen figured Pl. XIX, fig. 2.) Reduced ?. Photograph by Dr. A. L. du Toit. With restored outline-section (1 *a*), p. 224.
2. *Pseudoschloenbachia umbulazi*, Baily sp. Upper Senonian, Umkwelane Hill. Specimen No. 5494, p. 240. (Genotype.)
3. *Pseudoschloenbachia umbulazi* (Baily) var. *acuta*, nov. Same locality and formation. Specimen No. 5450, p. 241. 3 *a*. Peripheral view.
4. *Mortoniceras soutoni* (Baily). Umtamvuna River, Natal. B.M., No. C19441. Suture-line, after a drawing by the late G. C. Crick. (See p. 234.)

PLATE XXI.

1. *Mortoniceras woodsi*, sp. nov. Upper Senonian, Umkwelane Hill. Specimen N. 5451, p. 232. *a*. Side view. *b*. Peripheral view, not quite central. *c*. Suture-line (restored), × 2. Ventral lobe on left, antisiphonal lobe on right. *d*. Sectional outline.
2. *Placenticeras subkaffrarium*, sp. nov. Same locality. Senonian. No. 5106, p. 247. *a*. Side view. *b*. Peripheral view, not quite central. *c*. Sectional outline. *d*. Portions of suture-line, × 3, showing ventral lobe (arrow on right) and umbilical tubercle (left).

PLATE XXII.

1. *Parapachydiscus* sp. n. aff. *colligatus*, Binkhorst sp., × ½. Upper Senonian, Umkwelane Hill. No. 5489, p. 226. Side and peripheral views.
2. *Nostoceras ? natalense*, sp. nov. No. 2746. Upper Senonian, Umfolozi Valley, East of Railway, p. 248. *a*. Side view. *b*. Top view.
3. *Nostoceras ? subangulatum*, sp. nov. No. 2746A. Same locality and formation, p. 250. *a*. Side view. *b*. Septal surface at * in fig. 3 *a*, × 2. *D*. = dorsal, *V*. = ventral side, *I.Z.* = impressed zone. *c*. Suture-line, × 4 (restored), at * in fig. 3 *a*.

PLATE XXIII.

1. *Peroniceras* cf. *dravidicum*, Kossmat sp. Lower Senonian. High ground on north side of United Manuan Creek and Umsinene River, almost opposite junction. No. 4950, p. 295. *a*. Side view. *b*. Peripheral view. *c*. Sectional outline. *d*. Suture-line, × 2.
2. *Peroniceras* cf. *czörnigi*, Redtenbacher sp. (= *Peroniceras a* of Crick, 1907, p. 226, text-fig. on p. 226). B.M., No. C18245. Lower Senonian, Zululand. (See p. 296.) Internal (dorsal) portion of suture-line showing considerable asymmetry.
3. *Mortoniceras stangeri*, Baily sp. Senonian, Umtamvuna River, Natal. (See p. 297.) *a*. Sectional outline of No. C19459 (British Museum), × 2, at diameter = 25 mm. *b*. Portion of suture-line of same specimen, from lateral saddle (left) to antisiphonal line (right). *U*. = umbilical suture. (At diameter = 125 mm.) *c*. Internal suture (at diameter = 60 mm.) of Baily's co-type, 11368A (Geol. Soc. Coll.).

FIG.

4. *Mortoniceras vanuxemi*, Morton (Whitfield) sp. Upper Senonian, Northwest shore of False Bay. No. 4947, p. 308. *a*. Sectional outline. *b*. Suture-line, × 3. The dotted line on the right of the fig. 4 *a* denotes the position of the antisiphonal lobe.
5. *Diplomoceras ? indicum*, Forbes sp. Upper Senonian, Umkwelane Hill. No. 5465, p. 256.

PLATE XXIV.

1. *Parapachydiscus* cf. *wittekindi*, Schlüter sp. Upper Senonian, Umfolozi Valley, East of Railway. No. 3969, p. 229, × $\frac{2}{9}$.
2. *Bostrychoceras ?* sp. ind. Upper Senonian, Umkwelane Hill. No. 5478A, p. 255. (Squeeze of impression in matrix of *Diaziceras tissotiaeforme*.)
3. *Parapuzosia*, sp. nov. ? ind. Senonian, Railway Cutting, Umfolozi. Specimen figured, Pl. XIX, fig. 2, Pl. XX, fig. 1, p. 224. Cast of dorsal impression in outer whorl, showing ornamentation of missing inner whorls, × $\frac{1}{2}$.
4. *Baculites* cf. *aspero-anceps*, Lasswitz. Upper Senonian, Umkwelane Hill. No. 5480, p. 259. 4 *a*. Sectional outline.
5. *Baculites* cf. *brevicosta*, Schlüter. Same locality and formation. No. 5461, p. 260. 5 *a*. Sectional outline.
6. *Baculites capensis*, Woods. Same locality and formation. Suture-line of specimen No. 5486, p. 257, × 6.
7. *Baculites capensis*, Woods. Upper Senonian, Umtamvuna River, Pondoland. B.M., C19420. After a drawing by the late G. C. Crick (see p. 258), × 2.
8. *Kossmaticeras* (*Madrasites*) *bhavani*, Stoliczka sp. Senonian, south side of Manuan Creek Valley. No. 4909, p. 299.
9. *Subschloenbachia bispinosa*, nov. Upper Albian, Middle Branch, Manuan Creek. No. 4993, p. 285. (Sectional outline, restored.)
10. *Subschloenbachia prerostrata*, nov. Upper Albian, Middle Branch, Manuan Creek. No. 4970, p. 284. (Sectional outline.) The arrows indicate the spiral grooves of the cast, not visible on the shell.

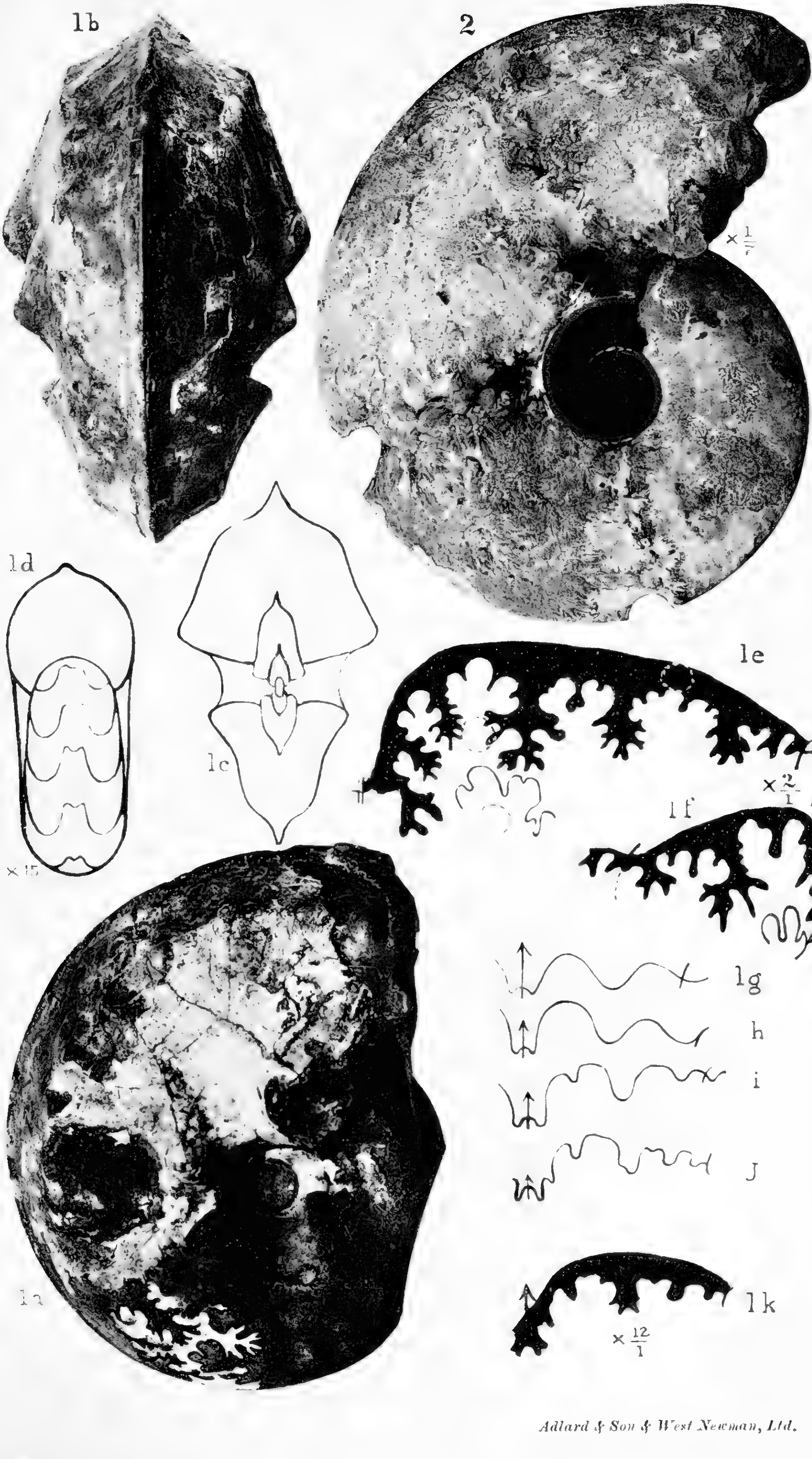
PLATE XXV.

1. *Pseudophacoceras manuanense*, nov. Albian, Manuan Creek (p. 281). *a*. Side view of holotype, No. 2725, × $\frac{1}{2}$. *b*. Suture-line of same, at diameter = 160 mm. *c*. Side view of specimen No. 2726. *d*. Sectional outline of same.
2. *Dipoloceras cristatum*, Deluc sp. Albian, Manuan Creek. No. 2728, p. 277. Mouth-border of very large example, taken from a cast of impression in matrix.
3. *Dipoloceras quadratum*, nov. Albian, Middle Branch, Manuan Creek. No. 4955, p. 278. *a*, *b*. Side and peripheral views. *c*. Sectional outline.
4. *Subschloenbachia* cf. *trinodosa*, Böse sp. Uppermost Albian, south side of Manuan Creek Valley. No. 4972, p. 285. Sectional outline.

PLATE XXVI.

FIG.

1. *Cheloniceras gottschei,* Kilian sp. Aptian, Powell's Camp, Upper Catembe. Specimen No. 5117, p. 312. *a.* Side view of body-chamber portion. *b.* Peripheral view of same. *c.* Restored sectional outline of inner whorl. *d.* Suture-line, restored from last two, at beginning of portion figured in 1 *a* (at *), × $\frac{8}{3}$.
2. *Cheloniceras* (***Acanthoplites*** *?*) *delagoense,* Krenkel sp. Same formation and locality. No. 5118, p. 316. *a, b.* Side and peripheral views. *c.* Suture-line, at diameter = 7·5 mm. (where whorl is coronatiform and constricted), × 6. *d.* Same at 15 mm. *I.* = antisiphonal line, × about 6.
3. *Cheloniceras hambrovii,* Forbes sp. Aptian, Atherfield Clay, Isle of Wight. (Writer's Coll.) Suture-line, at diameter = 10 mm., × 6. (See p. 317.)
4. *Aconeceras nisoides,* Sarasin sp. Aptian, Powell's Camp. No. 5119, p. 311. Side view (4 *a*) and sectional outline (4 *b*).
5. *Dipoloceras* sp. nov.? Albian, Middle Branch, Manuan Creek. No. 4903, p. 280. *a.* Side view, with restored outline of complete shell. *b.* Sectional outline, showing peculiar keel.
6. *Dipoloceras cristatum,* Deluc sp. Albian, Manuan Creek. Portion of suture-line, × 2, of specimen 2728, p. 277. *I.* = antisiphonal line, with keel of previous whorl (impossible to remove) concealing internal lobe.
7. *Anisoceras* sp. ind. Albian? Low Ridge, about three miles east of foot of Lebombo Mountains, north of M'Kusi River, due east of Ubombo. No. 4982, p. 288. Suture-line, × 8.



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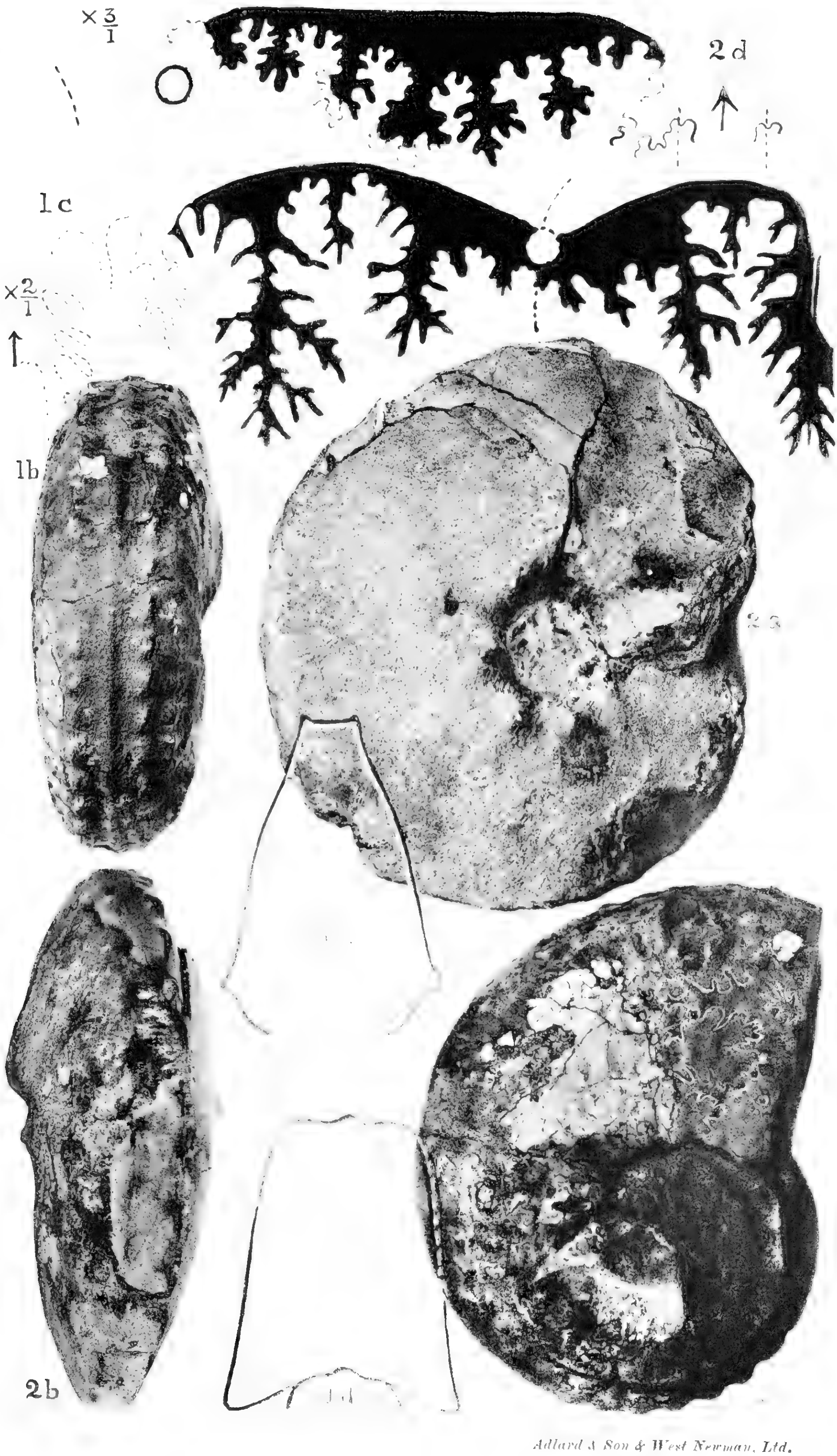

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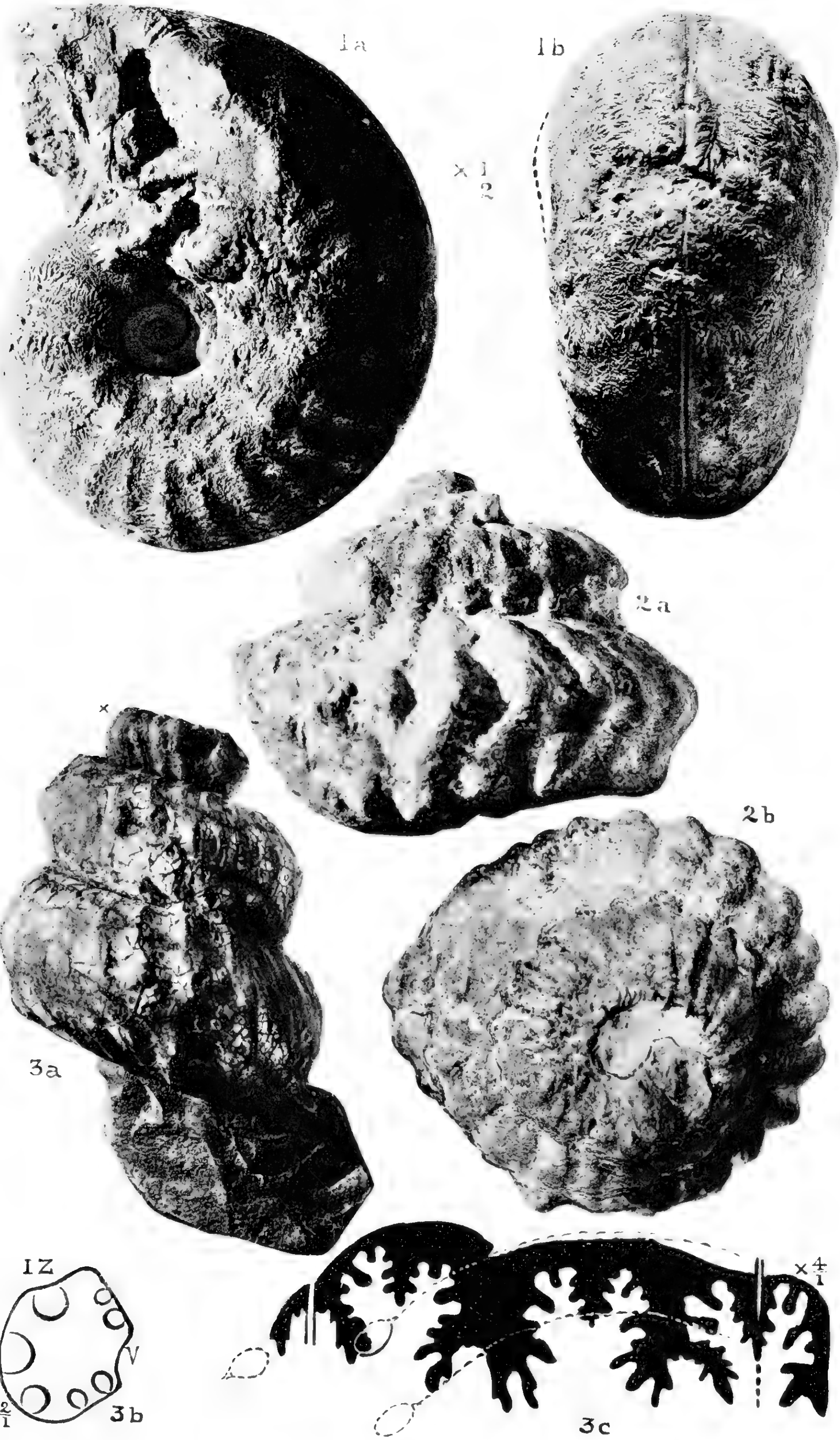

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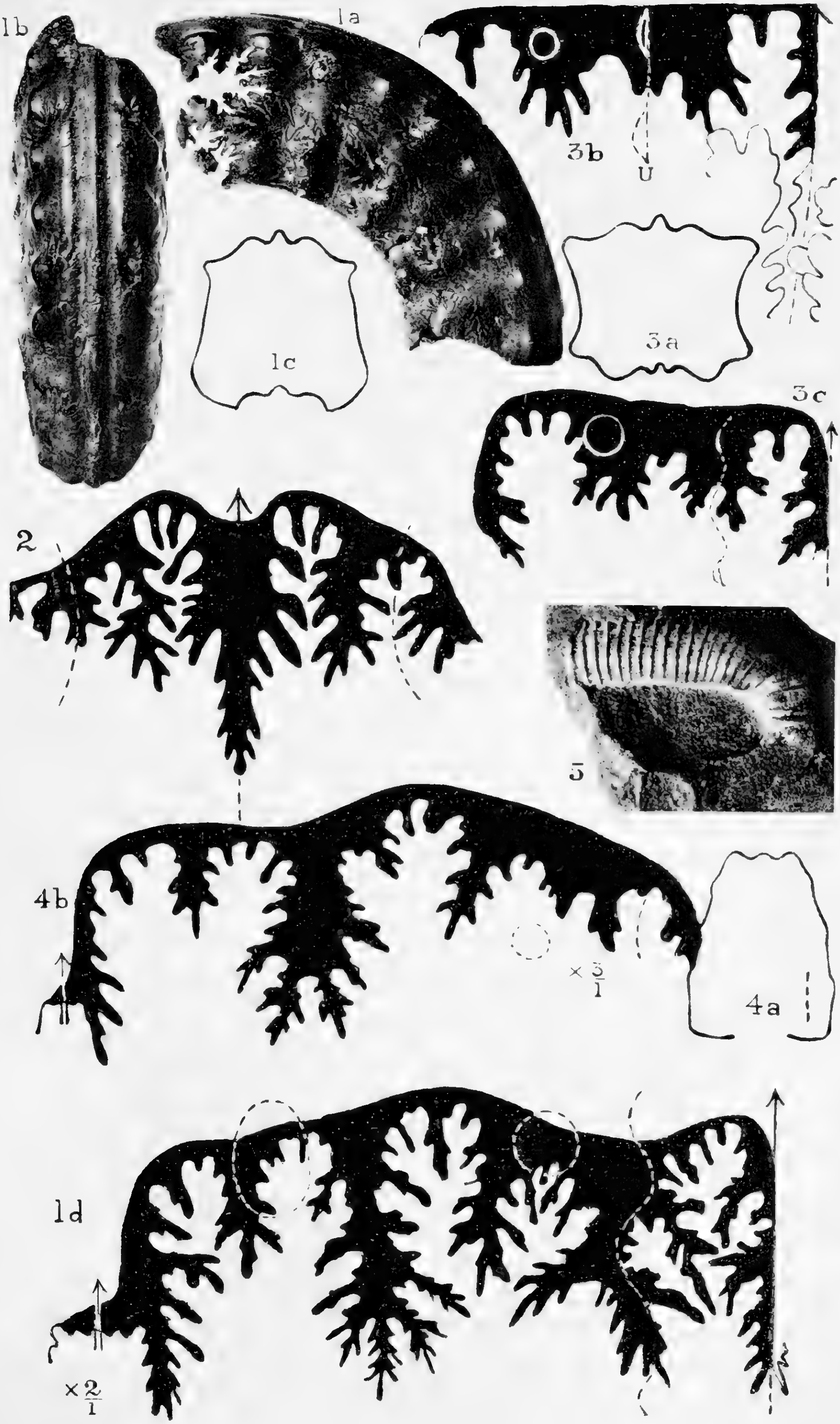

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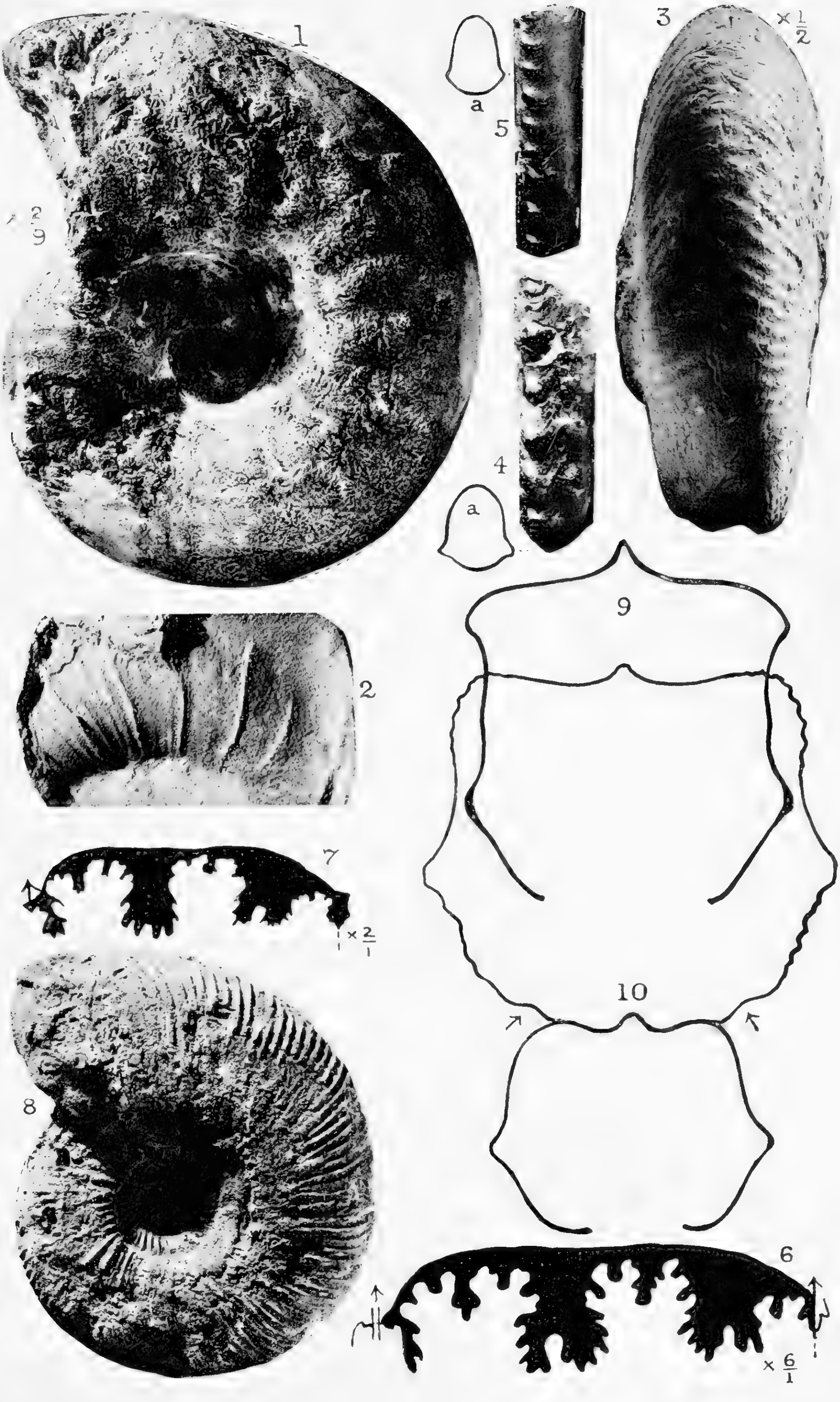

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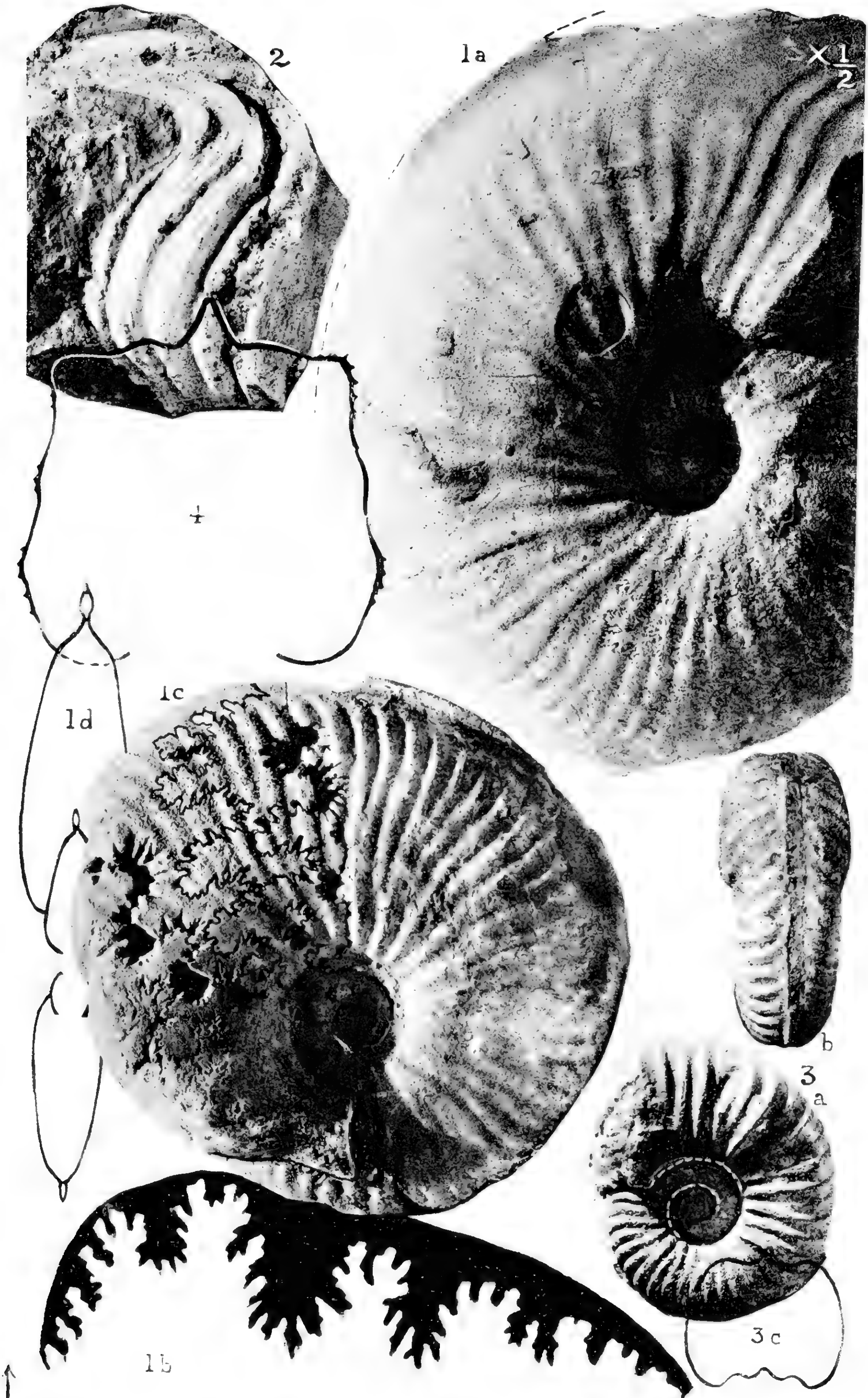
Plate XXV.



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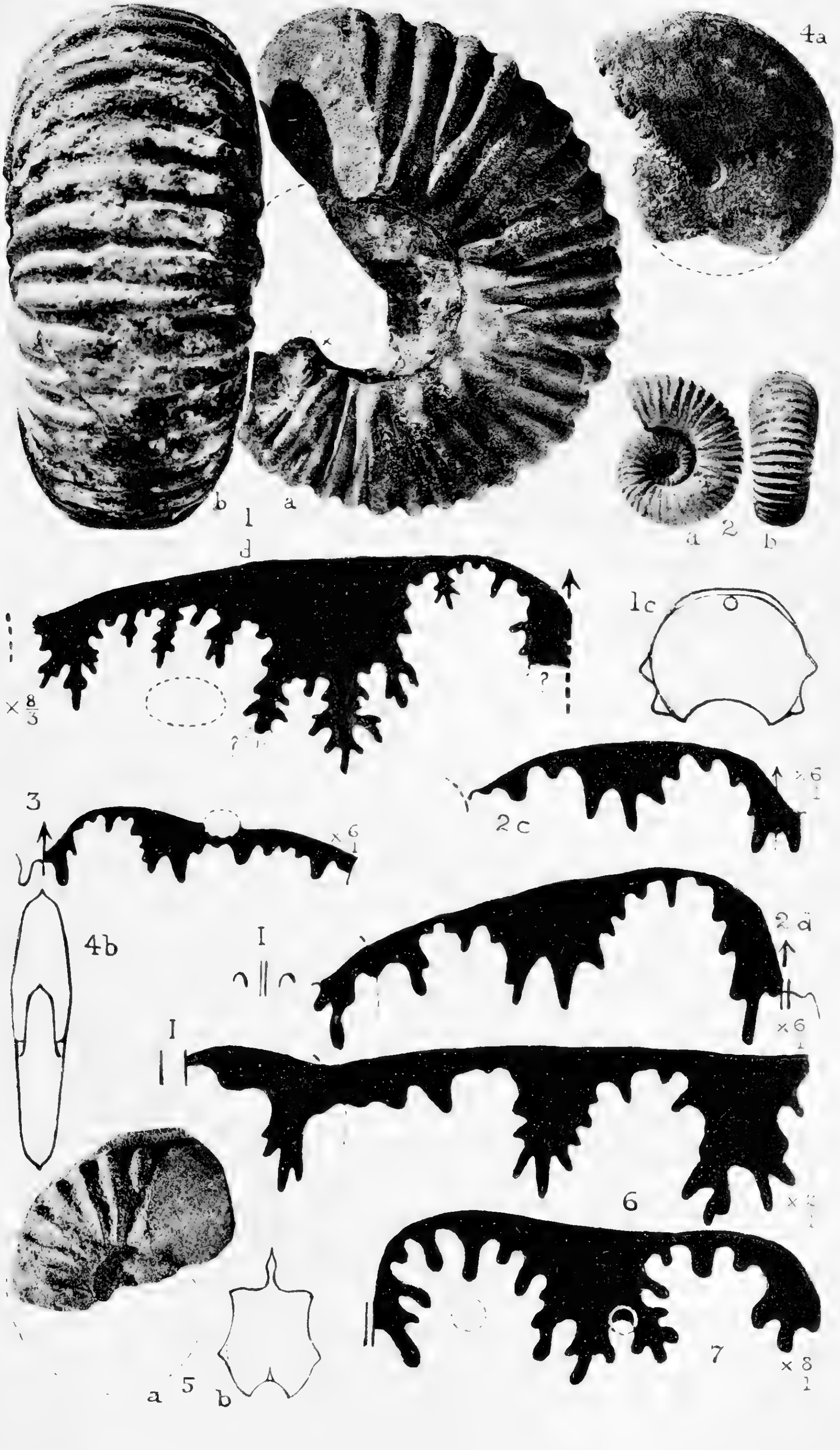

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17. — *The fauna and Stratigraphy of the Stormberg Series.* — By
S. H. Haughton, B.A., D.Sc., F.G.S., Hon. Curator of the Palaeontological Collections, formerly Assistant Director, S. A. Museum. (With 55 Text-figures.)

INTRODUCTION.

In the following pages an attempt is made to bring together facts, previously scattered through a number of publications, bearing upon the stratigraphy and palaeontology of the Stormberg Series and to incorporate among them the results of three collecting expeditions made by the author mainly in the districts of Herschel and Wodehouse. The whole of the fossil collection of the South African Museum has been reviewed — the animals by the author, the plants by Dr. A. L. du Toit. The work of the latter is not yet ready for publication; but Dr. du Toit has kindly forwarded a provisional list of his identifications, which is incorporated below. To him I am also indebted for constant critical advice and, as will be seen, I have drawn largely upon his published descriptions of the stratigraphy of the beds.

Mr. Macgregor, of the Rhodesian Geological Survey, has been good enough to supply me with notes and specimens from Southern Rhodesia. Rock-sections have been cut in the Geological Department of the University of Cape Town, where Professor A. Young has critically examined the petrological work, besides discussing the many interesting points of palaeogeography which arose. Thanks are due to the Royal Society of South Africa for a grant which resulted in the discovery of the skeleton of *Massospondylus harriesi*; and, among others, I am indebted for help to Dr. L. Péringuey for examination of the insect-remains and to Mr. K. H. Barnard for inspection of the crustacea.

FAUNA AND FLORA.

The following list shows the forms found in the Stormberg Series.

PLANTS.

(List supplied by Dr. A. L. du Toit.)

Neocalamites (*Schizoneura*) *Carrerei*, (Zeill.).
Neocalamites sp. Sew.

Danaeopsis hughesi, (Feist.).
Thinnfeldia odontopteroides, (Morr.).
Thinnfeldia lancifolia, (Morr.).
Thinnfeldia Feistmanteli, Johnston.
Thinnfeldia aquilina, Shirley.
Thinnfeldia trilobita, Johnston.
Taeniopteris Carruthersi, (Ten.—Woods).
Taeniopteris Tenison—Woodsi, Eth. jun.
Taeniopteris crassinervis, (Feist.).
Chiropteris Zeilleri, Sew.
Chiropteris cuneata, (Carr.).
Chiropteris copiapensis, Stein. et Solms.
Gingkoites (Ginkgo) digitata, (Brongn.).
Ginkgoites antarctica (Sap.).
Ginkgoites, nov. sp.
Baiera Schenki, Feist.
Baiera stormbergensis, Sew.
Baiera moltenensis, Sew.
Sagenopteris longicaulis, du Toit.
Cladophlebis (*Todites*) *Roesserti*, (Presl.).
Cladophlebis nebbensis, (Brongn.).
Callipteridium stormbergense, Sew.
Stenopteris elongata, (Carr.).
Stenopteris rigida, Dun.
Stormbergia Gardneri, Sew.
Sphenopteris alata, Brongn.
Sphenopteris lobifolia, Morr.
Pterophyllum natalense, du Toit.
Pterophyllum cf. *Footeanum*, Feist.
Phoenicopsis (*Desmiophyllum*) *elongata*, (Morr.).
Pachypteris acuta, du Toit.
Pachypteris lanceolata, Brongn.
Zamites sp.
Marattiopsis munsteri, (Goepp.).
Glossopteris browniana, Brongn.
Glossopteris conspicua, Feist.
Stachopitys sp.
Strobilites sp.
Rhexoxylon sp.

ANIMALS.

CRUSTACEA.

Cyzicus (*Euestheria*) *draperi* (Jones & Woodw.).
Cyzicus sp. Leriche.
Lepidurus stormbergensis, sp. nov.
Unnamed Ostracod.

INSECTA.

Coleopteron. Gen. et sp. indet.
Phthartus africanus, sp. nov.
Striatotegmen africanum, gen. et sp. nov.
Unnamed Blattid.
Archaegryllodes stormbergensis, gen. et sp. nov.
Eggs of Orthopteron?

PISCES.

Semionotus capensis, Sm.—Woodw.
Helichthys (?) sp.

REPTILIA.

Pachygenelus monus, Watson.
Tritheledon riconoi, Br.
Lycorhinus angustidens, gen. et sp. nov.
Sphenosuchus acutus, Htn.
Notochampsa istedana, Br.
Pedeticosaurus leviseuri, v. Hoep.
Erythrochampsa longipes, (Br.).
Thecodontosaurus browni, (Seeley).
Thecodontosaurus skirtopodus, (Seeley).
Thecodontosaurus minor, Htn.
Gyposaurus capensis, Br.
Aristosaurus erectus, v. Hoep.
Massospondylus carinatus, Owen.
Massospondylus harriesi, Br.
Massospondylus schwarzi, sp. nov.
Aetonyx palustris, Br.
Dromicosaurus gracilis, v. Hoep.
Plateosaurus stormbergensis, Br.
Plateosaurus cullingworthi, sp. nov.
Gryponyx africanus, Br.
Gryponyx transvaalensis, Br.
Gryponyx taylori, sp. nov.
Euskelesaurus browni, Huxley.
Euskelesaurus capensis, (Lyd.).
Euskelesaurus africanus, sp. nov.
Gigantoscelus molengraffi, v. Hoep.
Eucnemesaurus fortis, v. Hoep.
Melanorosaurus readi, sp. nov.
Geranosaurus atavus, Br.

PART I.

DESCRIPTION OF SPECIES.

CRUSTACEA.

ENTOMOSTRACA.

Family CYZICIDAE.

CYZICUS, Audouin.

Cyzicus (Euestheria) draperi (Jones & Woodw.)

1894. *Estheria Draperi* and *E. stowiana,* Jones & Woodward, Geol. Mag., N.S. Dec. IV, vol. I, p. 289. Pl. IX figs. 1*a*—*c*, 2.

The original description runs as follows: — "Size: Length of valve, 16 mm. Length of hinge-line, 11 mm. Height $10^1/_2$ mm. Valves suboblong, straight above, slightly curved below, rounded at the ends; anterior margin higher and less convex than the posterior. The interspaces on the surface are ornamented with coarse shallow pits, making an obscure reticulation. The umbo is just in front of the middle of the hinge-line."

I have examined a number of specimens from the shale-band at Siberia, Wodehouse, C. P. in the Cave Sandstone which belong to this species. None of them attain the dimensions recorded by Jones & Woodward; the largest valve seen by me is 12 mm. long, 8 mm. high and has a hinge-line of $8^1/_2$ mm. The corresponding dimensions on a number of the specimens are $7^1/_2$ mm., 5 mm. and 5 mm., while some have a length of not more than $2^1/_2$ mm.

Several of the specimens show the details of the external markings. The shape is somewhat variable, the smaller specimens approximating more to that figured by Jones & Woodward as *E. stowiana.* All agree, however, in the possession of the concentric ridges and, as far as can be seen, in the nature of the intercostal ornamentation.

In a valve having a height of 4 mm. there are 13–14 regularly spaced well-marked fine costae with broad interspaces. As the valves grow older and larger the costae increase rapidly in numbers and are crowded together near the ventral border in the larger specimens as in *C. mangaliensis.*

The intercostal ornamentation consists of shallow pits when viewed from without and pustules when viewed from within the valve. These are arranged in irregular rows and are set closely together so that there are 7 or 8 rows in each interspace. The pits are rounded rather than polygonal in outline. The older portion of the valve (that around the umbo) is smooth save for the concentric ridges. The pits are more prominent near the ventral, anterior and posterior borders of the valves. The abscence of pits near the umbo on the larger specimens is presumably due to wear or some other cause, as the small specimens occasionally show ornamentation over the whole valve.

Some of the valves show a considerably greater degree of ribbing than the more typical specimens. This variation in sculpture is paralleled in *C. murchisonae* in different valves of which Rupert Jones recorded variable ribbing.

The similarity of ornamentation between the valves of all sizes found at Siberia helps to prove the assumption here made that *C. stowiana* and *C. draperi* are but growth-stages of the one species. This possibility was mentioned by Jones & Woodward who had not, however, material for observing the intercostal ornamentation on the smaller forms nor intermediate valves showing the gradual changes in size. The variation in shape between specimens of the same size does not seem sufficient warrant for separating the specimens into several species. The species figured by Rupert Jones in his "Monograph of Fossil Estheriae" are variable in shape-characters; and the variations seen in *C. draperi* are no greater than those figured for his *Estheria ovata* or *E. minuta.*

In general form *C. draperi* seems to approach fairly closely to *C. mangaliensis* from the Rhaetic of India and from the Argentine.

Type. In the British Museum.

Locality. Harrismith, O. F. S.

Horizon. Shale-band in the Cave Sandstone.

Cyzicus sp.

1920. Leriche. *Estheria* sp. Rev. Zool. Afric. VIII p. 78. Pl. II, fig. 1.

Founded on specimens from the Lubilash Beds at Kitari, cañon of the Inzia, Belgian Congo.

"The valves are sub-oval; the beak is anterior and not prominent. The dorsal border is almost straight. The anterior border is rounded and passes insensibly into the ventral border, with which it forms a very regular curve. The ventral border is regularly convex; it joins the posterior border, which is oblique to the dorsal border, by a very obtuse angle. The valves carry about fourteen concentric ribs. The state of preservation does not permit of the presence of an intercostal ornamentation being stated."

Leriche states that these fossils belong to a group of "*Estheria*" characterised by a regular concentric ornamentation formed of prominent spaced ribs. This group has been called *Euestheria* by Deperet and Mazeran. The Congo form approaches most closely *E. mangalensis* but is distinguished by the slightly more elongate shape and the sharper demarcation of the posterior and ventral borders. *E. greyi* has a similar ornamentation but has a more oval and more inequilateral form.

Specific identification is not possible without a knowledge of the intercostal ornamentation.

Fam. APODIDAE.

LEPIDURUS, Leach.

Lepidurus stormbergensis sp. nov.

This form is represented in the South African Museum collection by a number of impressions on shale. Some represent isolated carapaces of immature animals; others more or less complete mature individuals. No specimen is perfect, and therefore several have been examined in the preparation of the following description. In some cases impressions of the appendages are fairly well-preserved, but detailed description of these is postponed.

The carapace is almost circular, slightly longer than broad, and deeply emarginate behind, the emarginate portion having an untoothed border. There is a strong median keel extending from the hinder border to a short distance behind the eyes.

Measurements of four carapaces of varying size are as follows:

Median length	Maximum length	Maximum breadth
9 mm.	10·3 mm.	10 mm.
9 mm.	11 mm.	10 mm.
11 mm.	13 mm.	12 mm.
	19 mm.	17·5 mm.

The smaller carapaces are isolated; the larger are attached in each case to the body.

The first antenna is short, single, possibly divided into two joints. As seen in specimen 5752 and possibly in 5751 it is similar in appearance to that of the recent ***L. viridis.*** The antenna is best seen in specimen 5758.

The second antenna cannot be distinguished.

The mandible is apparently an elongate plate (breadth greater than length) with a denticulate biting edge having 5 or 6 teeth. An impression is seen in no. 5758. In no. 5752 the maxilla is seen in juxtaposition with its neighbour of the other side.

The segments under the carapace are all provided with setose Phyllopod appendages.

In one specimen there are about 17 segments protruding beyond the carapace; of these at least 7 are longer than the others and may be regarded as true abdominal segments, although none of the segments are seen to possess feet. Each segment bears an encircling row of sharp spines which diminish in number posteriorly. The spines arise from near the middle of each segment and project well back behind the posterior border. Excluding the telson the body is about half the length of the carapace. (In another specimen the body is shorter, and the number of abdominal segments apparently six. This is possibly a female).

The telson is moderately short, spatulate, with a fairly well rounded posterior border and a pronounced longitudinal median keel. It carries no spines, and the edge is entire. In specimen 5763, however, the telson, instead of being spatulate, is somewhat pointed at the end, like a spear-head, and the lateral edges seem to be either serrate or provided with short spines. This may represent a variety; but the specimen is otherwise too incomplete for lengthy description.

The caudal filaments are fairly broad at the base, taper fairly rapidly and are covered with long fine hairs.

Specimen no. 5752 shows an oval body 2·5 mm. long situated in the neighbourhood of the 15th or 16th legs under the carapace, behind the mid-line of the carapace and to the side. The body is empty, but was probably an ovisac.

The form has been placed in the genus ***Lepidurus*** on account of the characteristic telson which distinguishes it at once from *Apus.* As far as can be discovered ***Lepidurus*** has not hitherto been described from Triassic deposits, although an allied form *Apudites* (or *Apus*) ***antiquus*** has been named by Schimper from the Lower Trias

(Voltzia Sandstone) of the Vosges. Unfortunately it has not been possible to consult the description of this form, which has been placed in the genus *Apus* by Ph. C. Bill (1914). The genus ***Lepidurus*** is not a member of the modern South African fauna although several species of *Apus* occur in the South African vleis, which habitually suffer periodic dessication.

Co-types. S. Af. Mus. Coll. Cat. Nos. 5751–5754, 5759–5761.

Locality. Siberia, Wodehouse, C. P.

Horizon. Shale-band near base of Cave Sandstone.

Class INSECTA.

Order COLEOPTERA.

Text fig. 1.

A piece of shale in the collection of the South African Museum contains the impression of what seems part of a coleopterous elytron. The impression is that of the posterior half of a right elytron, the anterior portion being overlain by another impression which, according to Dr. L. Péringuey, cannot be coleopterous. The impression

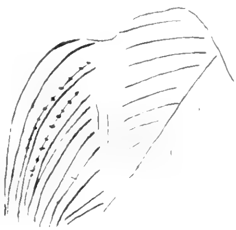


Fig. 1. *Coleopterous elytron.*

shows 8 main sub-parallel veins and a fairly broad fold. The sixth and seventh of the veins coalesce posteriorly. In addition there is a series of pustules (left in the impression as punctures) forming a fine line between the two outer veins, and another series between the next pair of veins.

The fragment (Cat. No. 5635) is too incomplete to justify naming. Triassic coleoptera have been described from Australia (families Hydrophilidae ?, Elateridae ?, Tenebrionidae ? and Malacodermidae) and from the Keuper and Rhaetic of Europe. No Permian forms have hitherto been described.

Locality. Siberia, Wodehouse, C. P.

Horizon. Shale-band near base of Cave Sandstone.

Order PLECTOPTERA.

Fam. EPHEMERIDAE.

Phthartus africanus, sp. nov.

Text fig. 2.

This is represented by several imperfect larvae of which the specimen figured (Cat. No. 5732) is nearly complete, lacking the head and lateral appendages. The cercal setae are faintly indicated — and have been drawn in on the evidence of a second specimen (No. 5733) consisting of the hinder portion of an abdomen in which the long setae are well-marked.

As preserved, the body without the cerci is 15 mm. long and 3·5 mm. broad in the middle.

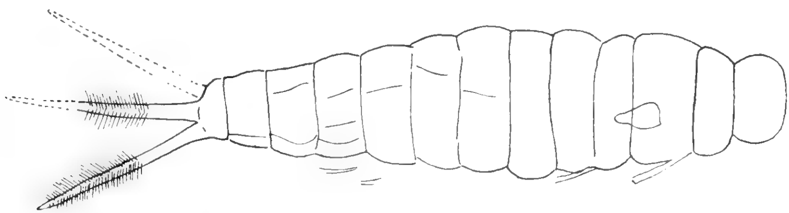


Fig. 2. *Phthartus africanus*, Htn.

The earliest Ephemerid larvae belong to the genus *Phthartus* Handl. from the Permian of Russia. The present form seems fairly similar to that genus, but the cerci are shorter and stouter. It may be grouped provisionally as *Phthartus africanus* sp. nov.

Type. Impression on shale — S. Afr. Mus. Cat. No. 5732.

Locality. Road-cutting, Siberia, Wodehouse, C. P.

Horizon. Shale-band near base of Cave Sandstone.

Order ORTHOPTERA.

Fam. MESOBLATTINIDAE, Handl.

Striatotegmen africanum, gen. et sp. nov.

Text fig. 3.

Tillyard's emendation of the characters of this family runs as follows: — "Subcosta much reduced. Radial area extensive and strongly developed, sending numerous branches towards the anterior

border, and reaching nearly to the apex. Media free, dividing into a variable large number of branches directed towards the apical border. Cubitus also free, branching variably, the branches directed towards the posterior border. Anal field large, well-defined, usually somewhat cultriform, with more or less curved veins running chiefly towards the posterior border. Intercalated veins and reticulation or cross-venation may or may not be present. Mostly small to medium-sized forms." (Proc. Linn. Soc. N. S. Wales, XLIV, 2, 1919, p. 366).

The fossil S. A. M. Cat. No. 5634 consists of a piece of shale and a partial counter-piece showing a nearly complete insect. One tegmen is folded back on the body; the other is spread out at right angles to the body and is preserved without the apex as an impression on slab 5634*a*.

The width of the tegmen is just over one-third of the probable length (which is about 9 mm.). The humeral area is narrow and distinctly less in length, from base to apex, than the anal area, and is bounded distally by a slightly double-curved sub-costa which is apparently unbranched. The humeral area is sharply pointed at the apex.

The radius is strongly double-curved. It gives off eight primary branches to the anterior border, excluding the forked distal end; of these, the first six are simple veins, the seventh and eighth forked. The median has four branches which apparently extend to the border below the apex. The cubitus has at least six branches.

In the area covered by R, M, and Cu strong raised ridges separate the veins. These are preserved as strong channels; but that they are not true veins is shown by the fact that they do not unite with one another basally, whereas the true veins do. There are faint indications of crossvenation on the proximal portions of the area covered by M and Cu.

The anal area has the *vena dividens* strongly marked. The first anal vein rises from the *vena dividens* but ends at the wing border just below the apex of the area. The third vein is forked at some distance from the border. The fourth vein is waved, as is the fifth — the latter being forked near its distal end. The sixth vein is also waved. In the anal area, there are indications of faint ridges between the veins. There is also a certain amount of irregular cross-venation.

Comparison of this wing with the forms from the Ipswich Beds of Australia gives the following results: — From ***Triassoblattina*** it differs in the narrower humeral area, the reduced nature of the subcosta, the stronger double-curving of the radius, and in the fact that none of the anal veins end distally on the ***vena dividens.*** There

are differences, too, from the genotype *T. typica* in the number of branches of R, M, and Cu.

From *Samaroblatta* it differs in the shorter and narrower humeral area, in that the distal portion of R probably reached the apex. In other points it approaches fairly closely to this genus, especially in the possession of intercalated ridges and a cross-venation. The difference in branching of R, M, and Cu is not of great moment; Tillyard has pointed out that not only different individuals of the same species of Cockroach, but also even the right and left tegmina of the same individual, show considerable differences in this respect.

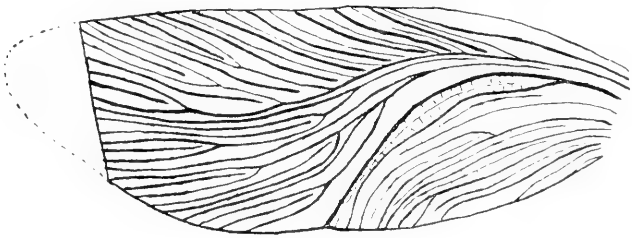


Fig. 3. *Striatotegmen africanum*, Htn.
Venation of tegmen.

From ***Austroblatta***, with which it agrees in size, it differs in the smaller humeral area, the pronounced bending of R, and the presence of intercalated veins.

In general characters it agrees closely with ***Mesoblattula*** from the Lias of Mecklenburg. It shows the same reduced subcosta; the humeral area shorter than the anal, the same strongly double-curved radius, and the same general features of M and Cu As in ***Mesoblattula*** there are intercalated ridges, and evidence of occasional cross-venation (cf. ***M. geinitziana***). Unfortunately the anal area is unknown in the genus ***Mesoblattula.*** Our form differs from this genus in that the anterior branch of the medial is apparently not forked; in this it differs also from ***Mesoblattopsis***, ***Liadoblattina***, ***Rhipidoblattina*** and ***Caloblattina***, and apparently agrees with ***Mesoblattina.*** It agrees also with ***Mesoblattina*** in the reduced humeral area and the simple subcosta; but the area covered by the radius is larger in the South African form, the radius is more strongly curved, and there are fewer primary branches. The tegmen, too, is somewhat broader.

Two genera of this family have been described from the "Rhaetic" of Tonkin — ***Rhaetoblattina*** Handl. and ***Hongaya*** Handl. Both of these are larger than our form. In each the humeral area is short,

the subcosta reduced to a single vein, the radius strongly double-bent so that it touches at its lowest point the middle line of the tegmen. *Hongaya* agrees with the South African form in that the upper branch of the median is not forked, in the general nature of the cubitus and median, in the fact that the first anal vein rises from the *vena subdividens* and ends distally on the wing border, and in the presence of intercalated ridges; but it differs in the number and nature of the radial branches and in the smaller size of the anal area. *Rhaetoblattina* has a larger anal area, comparable with that of our form, a small humeral area, and intercalated veins: but the median and cubitus are not so similar to our form as those of *Hongaya.* In neither of the Tonkin genera are cross-veins described; and Handlirsch was unable to discern them.

As was to be expected, this form shows close relationships with the Triassic, Rhaetic and Liassic forms of the Mesoblattinidae, and is more advanced than the Carboniferous and Permian members of the family. It does not seem to fall readily into any one of the described genera and for that reason the new generic name *Striatotegmen* is proposed for it, founded upon the following generic characters: —

Striatotegmen gen. nov. Tegmen small (under 10 mm. in length). Width just over one-third of the length. Humeral area narrow, and distinctly shorter than the anal area. Sub-costa slightly double-curved, unbranched. Radius strongly double-curved, almost reaching middle line of wing, with eight primary branches, of which the anterior six are simple. Upper branch of median unforked; upper branch of cubitus unforked. *Vena dividens* strong. First anal vein arising from *vena dividens,* but not ending distally on it. Intercalated ridges present, especially strong in radial, medial, and cubital areas. Cross-veins faintly indicated.

For this form the specific name *Striatotegmen africanum* sp. nov. is proposed.

Type. Insect on shale, and counter-impression. S. Af. Mus. Cat. No. 5634.

Locality. Road-cutting, Siberia, Wodehouse, C. P.

Horizon. Shale-band near base of Cave Sandstone.

Gen. et sp. indet.

Text fig. 4.

A fragment from Siberia (S. Af. Mus. Cat. No. 2340) shows portions of two Blattoid tegmina. Parts of the radius, median, and

cubitus of each tegmen are seen, but nothing of the subcosta nor of the anal area. Both ends of each tegmen are missing. Intercalated ridges are seen between the branches of the cubitus and median, but none in the area covered by the portion of the radius.

Nothing of the subcosta is seen, and but little of the radius. The distal branches of the radius are forked.

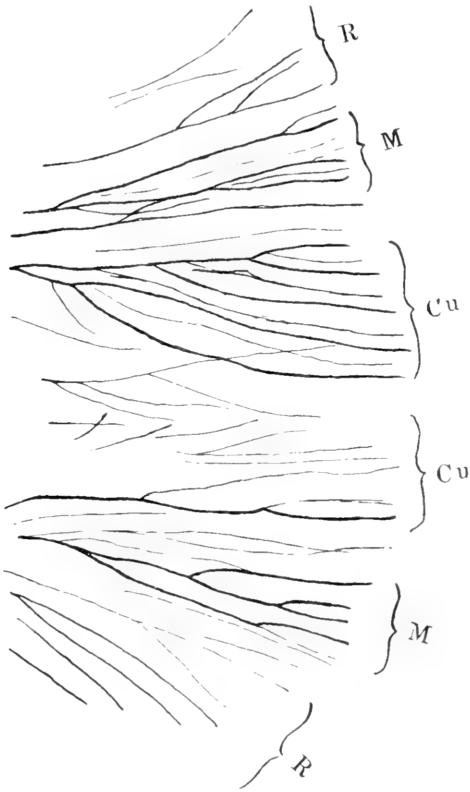


Fig. 4. *Blattoidea incert sed.*

Most of the distal portion of the median is preserved. The appearances of the two tegmina are slightly different. Each shows the primary branch forked near the extreme end, and, in addition, three other branches which arise by dichotomous division of a branch from the main stem. Intercalated ridges occur on one tegmen; on this side there appears to be a second primary unforked branch of

the median which is connected to the first fork of the first primary branch by a diagonal cross-vein.

The cubitus occupies a larger area than the median. It is dichotomously forked, and intercalated ridges are well-marked.

There is no sign of a strong ***vena dividens***, nor any indication of the anal area.

Locality. Road-cutting, Siberia, Wodehouse, C. P.

Horizon. Shale-band near base of Cave Sandstone.

Fam. GRYLLIDAE.

Archaegryllodes stormbergensis, gen. et sp. nov.

Text fig. 5.

This is founded on portion of the tegmen of a male Gryllid, about 11 mm. long as preserved and 5 mm. broad.

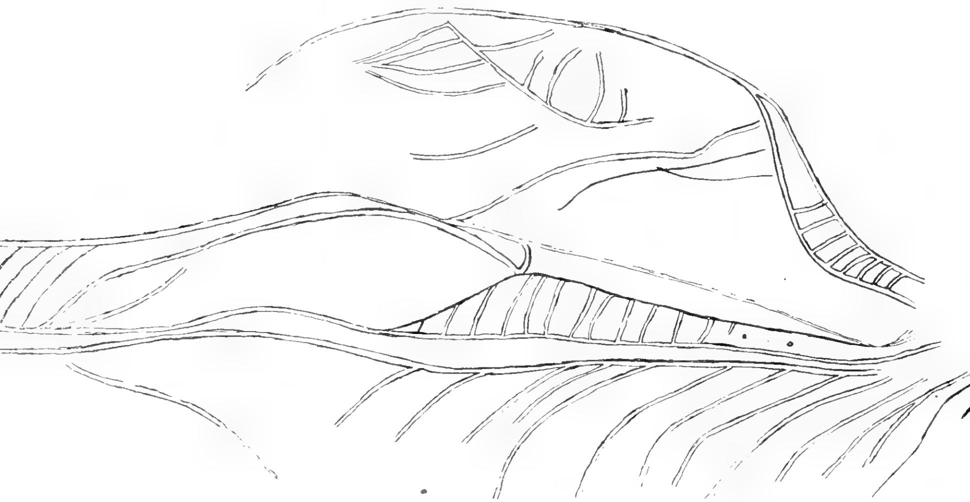


Fig. 5. *Archaegryllodes stormbergensis*, Htn. × 12.

The general arrangement of the main veins is similar to that in the recent form *Brachythripus* and is distinct from the hitherto earliest-described Gryllid — *Protogryllus* from the Upper Lias of Mecklenburg.

The subcosta is long and has a number of curved oblique branches in its proximal half. The radius lies close behind the subcosta.

The median is weak and joins the radius about half way along the latter forming a space with an acute distal angle. Distal to this a branch of the median again reaches up to the radius. Cross-veins connect the proximal portions of the radius and median.

There are indications of a drum between the branches of the cubitus, but the veining is not distinct. There are cross-veins between the second branch of the cubital and the first anal.

This is the earliest Gryllid described; and that fact, coupled with its lack of similarity with *Protogryllus* seem to justify the erection of a new genus which can be called *Archaegryllodes* n. gen., the species represented by the specimen under discussion being termed *A. stormbergensis.*

Type. Partial tegmen on shale. S. Af. Mus. Cat. No. 2341.

Locality. Road-cutting, Siberia, Wodehouse, C. P.

Horizon. Shale-band, near base of Cave Sandstone.

Orthopterous eggs.

Text fig. 6.

On the same slab of shale as that which contains the type of *Archaegryllodes stormbergensis* (No. 2341) are from ten to twelve

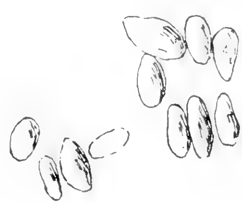


Fig. 6. Eggs of Orthopteron? × 8.

elongate oval bodies, which seem to be eggs of an Orthopteron. Each is about 1 mm. long by 0·4 or 0·5 mm. broad., and the specimens lie together in one mass.

There is a rough approximation to the form of a double row of eggs placed transversely, although one or two have been displaced from their original position; but the general appearance seems to indicate that the eggs were originally in an ootheca similar to that of some Orthopterous insects, but that the cover has disappeared.

PISCES.

TELEOSTOMI.

Gen. SEMIONOTUS, Ag.

Semionotus capensis, Sm.—Woodw.

1888. Smith—Woodward. Quart. Journ. Geol. Soc. XLIV, p. 138.
1901. Schellwien. Schrift. Physik.-oekonom. Gesell. Konigsberg. XLII.
1909. Broom. Ann. S. Afric. Museum VII, part 3, p. 262.

Since Broom's description, the South African Museum has received no further examples of this well-known fish, and it will suffice to quote the main points of Broom's analysis of the form.

"The majority of specimens measure from 160 to 210 mm. in length. In the example which is 210 mm. long, the body is 42 mm. in depth at the deepest part, and the head measures 48 mm. to the back of the operculum.

Schellwien has recently described a number of specimens and has shown the more important features of the skull structure. The specimens I have examined confirm most of his observations, but in one or two points I am inclined to differ from him.

Almost every detail of the skull is now known except the basicranial region. The frontals are large, and extend from the nasal region to behind the plane passing through the back of the orbit. The back part of the bone is about twice as wide as the middle portion. Behind it is a large oblong parietal. Below the parietal is a slightly narrower squamosal. My specimens do not satisfactorily show the supratemporal region, but Schellwien finds a narrow supratemporal and a post-temporal.

The opercular bones are very like those of *Lepidotus.* The operculum differs in being relatively considerably wider in its lower half. Inferiorly it joins the subopercular in a manner very similar to that in the better known genus. The subopercular in *Semionotus* is only about one-third the size of the operculum instead of half as large as in *Lepidotus*, while the interopercular is less than half the size of that in *Lepidotus.* In front of these three opercular bones is a narrow curved preopercular, along which there runs a mucous canal.

In Schellwien's diagrammatic restoration the postorbital seems to

me to be rather too small, while the interopercular is much too large. Above the anterior end of the long preopercular is an elongated suborbital smaller in size than the postorbital. The portion of the figure dealing with this region is, in my opinion, erroneous.

The lower jaw has an elongated triangular dentary and a powerful angular.

The palato-pterygo-quadrate arch is fully ossified, but the exact limits of the different elements cannot be made out with certainty. There is a long narrow bone below the quadrate stretching from the articular region to the lower end of the hyomandibular. This would seem to be the symplectic. The hyomandibular is a powerful bone and fairly similar to that of the ordinary Teleosteans. In addition to supporting the opercular bones and the quadrate arch, it supports the hyoid arch. There is a large quadrangular epihyal and an elongate triangular ceratohyal. The interhyal has probably been cartilaginous, as has also probably been the hypohyal and the urohyal. Under the subopercular are six branchiostegals.

The clavicular arch consists of the clavicle, supraclavicle, post-clavicle and post-temporal, but there seems to be no trace of an infraclavicle. A mucous canal crosses the supraclavicle obliquely as in the Palaeoniscias. There is a small ossification which possibly may be the coracoid as is thought by Schellwien.

The pectoral fin consists of 14 rays with 5 or 6 fulcra in front. The rays are much flattened distally, but apparently not branched.

The pelvic fin consists of 7 rays which are branched distally. The fulcra are powerful.

The dorsal fin begins exactly in the middle of the back of the fish, and consists of 13 rays, of which the last 3 are small. All the rays are branched distally and articulated. In front are a row of very powerful fulcra, 9 in number. The anal fin consists of 9 rays with 9 powerful fulcra in front.

The caudal fin consists of 16 rays, all of which are branched and articulated. Below and in front of the first ray are 14 fulcra, and 14 fulcra also lie above the tail, gradually passing into the dorsal scales in front. The rays of the dorsal, anal, and caudal fins are double. Though the tail is in a sense brevi-heterocercal the upper portion is really continued as a long, slender process bearing small rhombic scales about 20 mm. beyond the end of the middle of the tail."

Type. In British Museum.

Locality. Ficksburg, O. F. S.

Horizon. Cave Sandstone.

Helichthys (?) sp.

A piece of shale from the deposit at Siberia, C. P., shows portion of the body of a small fish including the proximal portions of the anal and pelvic fins.

The body must have been fairly long and shallow. The pelvic fin is not entire, but the preserved portion consists of 13 rays, spread out into something of a fan-shaped body. They show no evidence of bifurcation. The anal fin is preserved in its proximal half; it is composed of 35 or 36 rays, of which the first seven at least increase rapidly in size from the first. There is no evidence of the presence of fulcra. The dorsal fin is not preserved.

The flank-scales are small, rhomboidal, without external ornament. There seems to be evidence of a single longitudinal groove on the inner surface.

It is possible that the form is allied to that described by Broom as *Dictyopyge formosa.* It is doubtful, however, whether that species can be ranked in the genus *Dictyopyge* as defined by Egerton. Except in the pectoral fin no fulcra are seen; while there is no evidence of bifurcation of the fin rays in the specimens of *formosa* which we possess. Rather does the form seem to be generically identical with *Helichthys*, agreeing in the comparative scarcity of fulcral bones, in the simple unbifurcated rays, and in general characters. Fulcra are not well-marked, but are present.

It is considered, therefore, that the type specimen of *Dictyopyge formosa* (S. A. Mus. Cat. No. 2761) must be known as *Helichthys formosa.*

Type. Incomplete small fish. S. A. Mus. Cat. No. 5130.

Locality. Siberia, Wodehouse, C. P.

Horizon. Shale-band near base of Cave Sandstone.

Class REPTILIA.

Super-Order ANOMODONTIA, Owen.

Order THERIODONTIA, Owen.

Pachygenelus monus, Watson.

1913. Watson. Geol. Mag. N. S. Dec. V. Vol. X., p. 145, figs 1, 2.

This form is known only from the anterior portion of a small dentary. There are only two incisors, of which the first is much bigger than the second. The canine is large, of oval section. There is a long diastema between the canine and the first molar. "The

(molar) teeth are small, single-rooted, and narrow from side to side; the root is deep and closely fits its alveolus." "The crown is of an irregular oval shape, widest in front, where it is about three-quarters of its length. There are four cusps arranged longitudinally and forming the outer side of the tooth; .... the first was much the largest, and they gradually decline in size and height to the fourth. On the inner side is a strong cingulum. This shows a very faint crimping".

Type. Imperfect dentary.

Locality. Witkop, Albert, C. P.

Horizon. Red Beds.

Tritheledon riconoi, Broom.

Text fig. 7.

1912. Broom. Ann. S. Afric. Museum VII, 5, p. 334, Pl. XXII, figs. 30–36.

The type of this form is a "portion of a left maxilla with the roots of 7 teeth and two imperfect immature teeth, portion of the left jugal, and a fragment of the left palatine" from Paballong, Mount Fletcher District, Griqualand East, which is in the collection of the South African Museum.

In 1914, the discoverer of this fragment, the late Dr. M. Ricono, forwarded to the Museum a small parcel containing a portion of a skull and eleven dissociated vertebrae from Paballong, all of which undoubtedly belong to the same animal as the fragment described by Dr. Broom. Dr. du Toit, who has since visited the locality, informs me that the fossil came from the Red Beds. It was found within a quarter of a mile of the spot from which the type of *Sphenosuchus acutus* came, and from an horizon within 10 or 12 feet of it.

This new skull fragment consists of the greater part of the right maxilla including the palatal portion, the base of the jugal arch, part of the left maxilla, and a portion of the right palatine. The first seven molars are present. They agree with the description given by Dr. Broom as far as can be seen from the crowns of the 4th and 6th teeth, which are the only teeth preserved entire. The 7 teeth occupy a length of 15·2 mm.

In front of the 1st. molar there is a markedly concave diastema of which a length of 9 mm. is preserved. There is no remnant of the canine present, and if the base of the canine was on the same level as the base of the molars, the diastema would probably have been about 12 mm. long. It has a maximum height of 4 mm. above the base of the teeth.

The maxillary part of the palate is complete on the right side. It is 18 mm. long, and narrows slightly anteriorly. Between the bases of the 1st. molars the palate, when complete, had a width of 26·5 mm., while at the point of junction of the maxilla with the premaxilla the width was 22 mm. The alveolar part of the bone which contains the roots of the molars is fairly massive, but the palatal portion of the bone has a thickness of but 2 mm.

In front of the maxilla a small palatal fragment of the premaxilla is preserved, while posteriorly a section of the right palatine is seen forming a vertical wall to the narial passages and curving downward and inward to form part of the secondary palate, articulating on the palatal surface with the maxilla. The vault of the palate is low, being a flattened concavity.

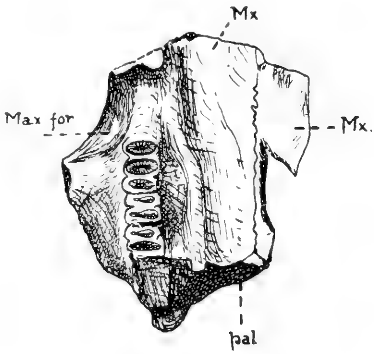


Fig. 7. *Tritheledon riconoi*, Br.
Palatal view of right maxilla.

By placing the type specimen in its correct position with respect to this fragment it is seen that in all probability the first molar tooth on the type is in reality the second molar of the animal. It would thus appear that this form has 10 molars; for it is improbable that any are missing from the posterior part of the type, the alveolar border of the maxilla thinning away rapidly behind the last of the series displayed.

All the vertebrae preserved are incomplete. The largest — probably from the mid-dorsal region — has a centrum 34 mm. long, whose ends are 22 mm. high and 20 mm. broad. The ends of the centra are slightly concave. The centra are regularly constricted, the median width being 16 mm., and along the ventral surface is a well-defined median longitudinal grove, which broadens at the two ends. The centra are relatively longer than those of *Cynognathus.*

The neural canal is well-defined. The transverse processes are placed midway along the vertebra, and arise at the level of the top of the centrum. The base of the process occupies at least two-thirds of the entire length of the centrum. No zygapophyses are preserved.

Type. Skull-fragment S.A.M. Cat. No. 1885.

Locality. Paballong, Mt. Fletcher, Cape Province.

Horizon. Red Beds.

LYCORHINUS ANGUSTĪDENS, gen. et sp. nov.

Text fig. 8.

The type of this new form consists of a portion of the left ramus of the lower jaw of a Cynodont from Paballong, Mount Fletcher, presented to the Museum by the late Dr. M. Ricono. The fragment shows the canine, 7 molars and the impressions of 4 others, making 11 in all. The ramus lacks the lower border, and is broken off anteriorly at the front of the canine and posteriorly at the ninth molar.

The canine is long and powerful, with a long root, and curves

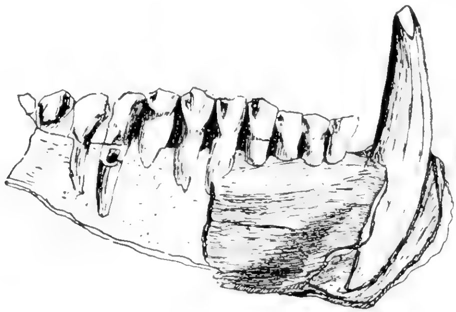


Fig. 8. *Lycorhinus angustidens*, Htn.
Type dentary.

slightly backwards. The point is absent and the inner anterior side of the upper sixth is bevelled off by rubbing against the canine of the upper jaw. In section the tooth is oval with the longer diameter along the jaw. The anterior border is ridged and serrated for the greater part of its length; the posterior border is also ridged, but is unserrated.

Close behind the canine, separated from it by a diastema measuring at the most 1·5 mm, come the molars. They are all of the same pattern, increasing gradually in size to the fourth, and decreasing

from the eighth. The roots are long and nearly circular în cross-section. Half-way up the crown on the inner side is a cingulum above which the crowns are laterally compressed, so that seen from above they are considerably longer than broad. Above the cingulum on the inner side the crown slopes upwards and outwards and the thinning of the crown thus produced is also accentuated apparently by a somewhat inwardly-directed slope of the outer face. Each molar from the 4th onwards is provided with two cusps, a large anterior cusp occupying two-thirds of the grinding surface, and a much smaller, somewhat lower posterior cusp. On the inner face there is a groove running between the ridges which descend from the cusps to the cingulum. The second and third molars are provided each with an additional cusp in advance of the large one which has been called the anterior cusp; and to a lesser extent this feature is also seen on the first and fourth molars. The crowns are but scarcely worn. The outer side is unfortunately not seen, but its general characteristics can be obtained from the impressions of the 8th, 9th, and 10th molars.

The total length of the fragment as preserved is 46 mm. The crown of the canine is 19·5 mm. high, and 7 mm. long at the base. The first ten molars together occupy a length of 33 mm. At the canine the depth of the dentary was about 17 mm.

Type. Portion of lower jaw with teeth. S.A.M. Cat. No. 3606.

Locality. Paballong, Mount Fletcher, C.P.

Horizon. Red Beds.

Super-Order ARCHOSAURIA.

Fam. SPHENOSUCHIDAE nov.

Sphenosuchus acutus, Htn.

Text figs. 9—16.

1915. Haughton. Ann. S. Afr. Mus. XII, 3, p. 98.

Since the original description of this form was published a certain amount of additional development has been done upon the type specimen, which necessitates slight additions and emendations. It has been thought best, therefore, to recast the description.

The skull is somewhat crushed but nearly whole, and shows all the external details. It is larger than that of ***Euparkeria***, and is comparatively more pointed, longer, and narrower. The orbits are rounded, and wholly in the posterior half of the skull. The supra-

temporal fossa is elongate, oval in shape, and larger than that of ***Euparkeria*** or ***Ornithosuchus.*** The shape of the infratemporal fossa is characteristic in that its anterior border, formed by the jugal and postorbital, passes upwards and forwards instead of upwards and backwards as in ***Euparkeria*** and ***Ornithosuchus***; so that the superior length of the opening is about equal to the inferior length.

The snout is characterised by the fact that the premaxilla does not form an anterior border to the nostrils, these being quite terminal. Further, there is no trace of a median septum dividing them. The roof of the snout is formed by the paired nasals, which are broken posteriorly. The extreme tip of the left nasal is missing but the bones were obviously pointed in front. The whole of the

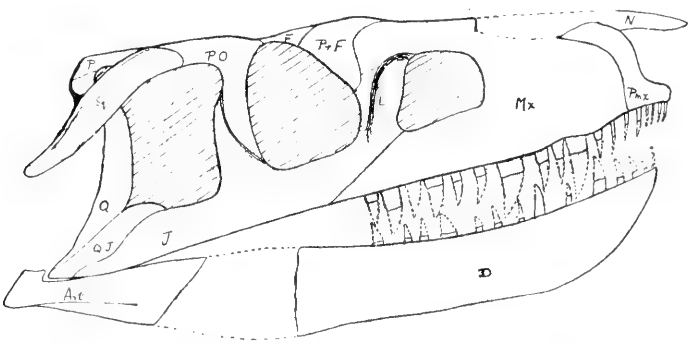


Fig. 9. Side view of skull of *Sphenosuchus acutus* Htn. × ½. (Slightly restored.)

posterior and lower borders of the nostril are formed by the premaxilla, which sends back a process separating the forward portion of the maxilla from the nasal. The nostril seems to have had an upper prolongation between the nasal and premaxilla. The premaxilla carries apparently three or four simple pointed teeth.

There is no septomaxilla present on the face.

The antorbital vacuity is large, and is sunken in the face, having borders which make an oblique angle with the sides of the face. The whole of the anterior and lower borders is formed by the maxilla, which extends back only as far as the front of the orbit — not nearly so far as in *Euparkeria.* The maxilla carried about 12 teeth, of which 8 are preserved on the right side. Unfortunately, not one possesses the crown; but a small tooth in the lower jaw shows serrations on the anterior border similar to those of the carnivorous Dinosaurs. The teeth are flattened laterally, and vary considerably in size. The first maxillary tooth has an antero-posterior

diameter of just over 1 mm.; the probable 6th, which is the largest, has a diameter of 7·5 mm. The teeth do not increase nor decrease regularly in size from front to back of the jaw, but are variable.

The surface of the maxilla is plentifully supplied with grooves and small foramina for blood-vessels.

The nasal is an extremely long bone forming the upper surface of the skull from the tip of the snout nearly to the plane of the

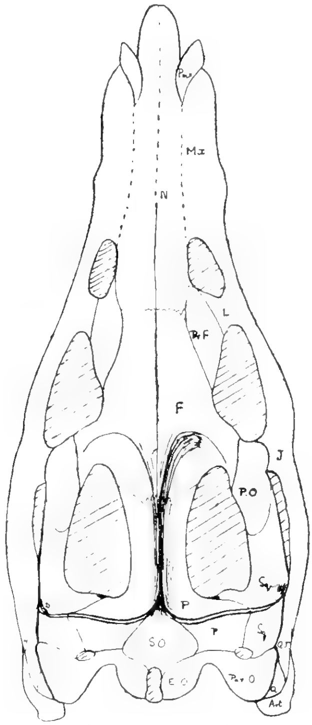


Fig. 10. Top view of skull of *Sphenosuchus acutus* Htn. × ½.
(Slightly restored.)

front of the orbit. It forms none of the posterior border of the nostril. The greatest width across the pair of bones is 20 mm. — at the back — while the length is about 88 mm.

The lachrymal forms the whole of the upper border and most of the posterior border of the antorbital vacuity, besides forming the larger part of the anterior orbital border.

The prefrontal is a small bone lying between the frontal, nasal, and lachrymal. Below it has a lobe-like extension articulating with

the lachrymal, so that it forms about 18 mm. of the orbital border; but its width throughout most of its length is only about 6 mm.

I can see no evidence of a postfrontal. Even if one be present the frontal is still peculiar in that it passes back to form part of the anterior border of the upper temporal fossa, separating the postorbital from the parietal. The interorbital region has a median elevation, broadened at the level of the postorbital bars, and narrowing posteriorly until it forms the median parietal crest. On each side there is a slight supraorbital crest; and between this and the median ridge is a well-defined channel. The frontal forms half of

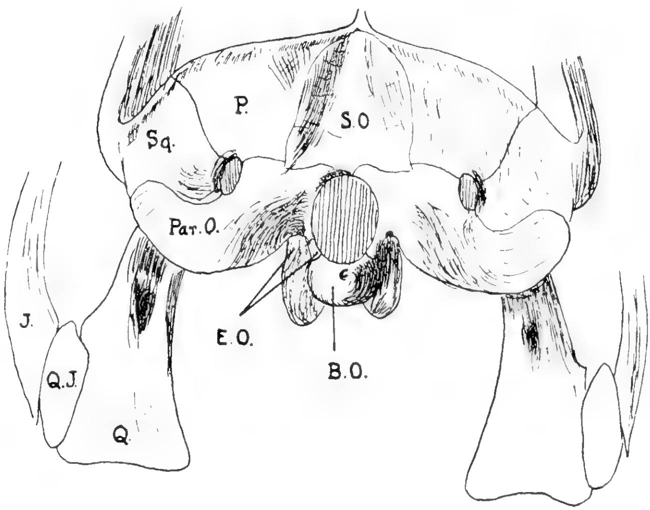


Fig. 11. *Sphenosuchus acutus*, Htn.
Occipital view of skull. × 1.

the supraorbital border. Its greatest length is in the middle line, the sutures with the parietals passing well forward from a point one-third along the parietal crest nearly to the anterior extremity of the supratemporal fossa.

The postorbital bar differs from that in *Euparkeria* and the allied forms in that its upper end is in advance of the lower. The descending portion of the postorbital is thus inclined backward instead of forward, lying in front of the ascending process of the jugal. The postorbital forms most of the outer border of the upper temporal fossa and a small portion of the upper border of the lower opening, anteriorly articulating with the frontal, and posteriorly overlying a part of the squamosal. Nowhere does it meet the parietal.

The jugal is a tripartite bone. Its anterior process forms the inferior border of the orbit, and articulates with the lachrymal and the maxilla It does not pass up in front of the orbit as in *Euparkeria.* The ascending process lies behind and superiorly internal to the postorbital and is inclined slightly forward. The posterior process forms most of the zygomatic arch, lying outside the quadrato-jugal.

The lower temporal opening has a rhomboidal shape, being bounded by the postorbital, jugal, quadrato-jugal, quadrate, and squamosal. It is slightly bigger than the upper opening.

In both *Euparkeria* and *Ornithosuchus* the quadrato-jugal is a fair-sized bone whose articulation with the jugal passes downward and forward, and which passes up in front of the quadrate to meet the squamosal. In this form, however, the quadrato-jugal is a comparatively small flat bone which lies in the lower posterior corner of the lower fossa and whose articulation with the jugal passes downward and backward. It lies under the jugal and overlaps part of the quadrate. There is no foramen between it and the quadrate.

The quadrate is a long, strongly developed, fixed bone with a somewhat expanded lower end. Its upper end is fixed between the squamosal and the opisthotic. The external surface shows a well-marked longitudinal depression at the lower end of the upper half. The front edge of the bone is thin, the posterior border well rounded.

The squamosal is a strong bone, articulating with the postorbital, quadrate, parietal, opisthotic, paroccipital, and exoccipital. It forms the outer posterior corner of the skull, *i. e.* half the outer and posterior borders of the supratemporal fossa. It passes over on to the occipital plate and takes part in the border of the small posttemporal foramen.

The parietal has a strong median crest which divides posteriorly and forms the upper border of the occipital plate. The bone passes over this lateral crest to form part of the occipital plate. It articulates on the plate on the inner side with the supraoccipital, on the outer with the squamosal, and below with the exoccipital, forming a small part of the border of the posttemporal fossa. Anteriorly the bone articulates with the frontal, and below with the opisthotic and alisphenoid. As in *Ornithosuchus* there is no interparietal,

The foramen magnum is an oval opening 12 mm. high and 10 mm. broad, lying high in the skull but well in the lower half of the occipital plate.

The supraoccipital forms a very small portion of the upper border

of the foramen magnum. It is a triangular bone with a narrow short shaft passing down to meet the foramen magnum. Its apex lies under the bifurcating ridge of the parietal. The surface is slightly concave.

The suture between the exoccipital and paroccipital process is not to be seen. The latter is fairly high and fairly thin; its outer corner is bent almost horizontally and rests on the backwardly-directed part of the squamosal.

The basicranial region differs from that of the Theropodous Dinosaurs as exemplified by *Plateosaurus erlenbergensis.*

The basioccipital forms the majority of the rounded condyle, which lies wholly below the foramen magnum and is slightly hol-

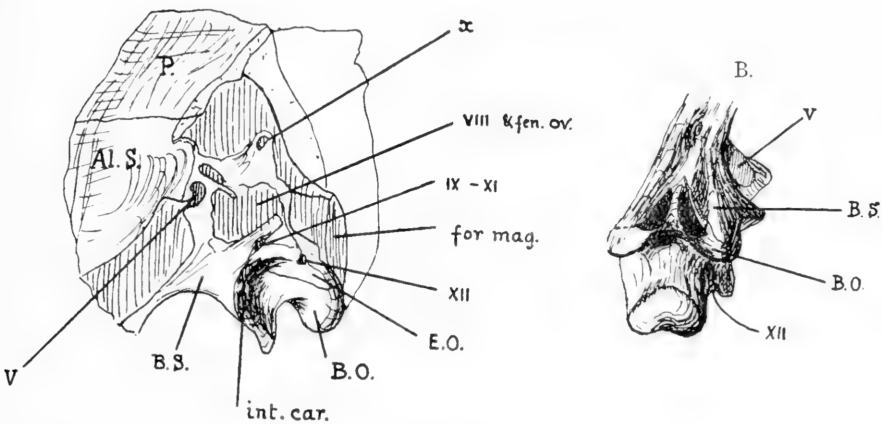


Fig. 12. *Sphenosuchus acutus,* Htn.
A. Side view of basicranium and brain-case.
B. Ventral view of basicranium.

lowed out in the middle of its hinder surface by a small notochordal pit. The bone also forms the base of the foramen magnum. Anteriorly it thins considerably and then thickens again; seen from the side its lower border is very strongly concave. The basioccipital tubera are strongly projecting and between them the transverse ridge is deeply hollowed out. The tubera are formed wholly of the basioccipital, in strong contra-distinction to those of *Plateosaurus* and are thus somewhat reminiscent of the tubera in the Anomodontia. This likeness is further intensified by the fact that the basisphenoid sends back a process on either side to support the anterior wall of each tuber. Between these basisphenoidal processes and anterior

to the transverse ridge the basioccipital rises considerably so that seen from below it has a deep central pit. This pit is triangular in shape with its base behind and its apex in front. The base is formed wholly by the basioccipital. The upper portion of the sides is also formed by the basioccipital, but the larger, lower portion is formed by the basisphenoid. Superiorly this pit divides into two canals separated by a rod of bone which passes upwards from the transverse basioccipital ridge and then turns forwards. The openings to the canals are elongate vertically. Superiorly the basioccipital meets the exoccipital. On the left hand side of the skull the suture can be seen running from just below the top of the condyle — the exoccipital forming a very small portion of the condyle — forwards and slightly upwards to a point above the basioccipital tuber, and then passing downwards so that the exoccipital forms part of the lateral ridge running down to the tuber and meets the basisphenoid. The exoccipital forms all the lateral border of the foramen magnum, and the two almost meet above the foramen. The foramen for the XIIth nerve (hypoglossus) is single and small.

The basisphenoid sends back two processes as supports for the tubera, as mentioned above. In front of these the bone narrows somewhat and then sends forward the two pterygoid apophyses. At its narrowest the bone is deeply grooved in the median line. The lower border of the pterygoid apophysis bends down sharply.

Between the exoccipital and the basisphenoid on the side is a small foramen, presumably that of the carotis interna. Between the exoccipital and a dumb-bell shaped piece of bone forming part of the side wall of the brain and seen in oblique section is another foramen. The bone is probably a portion of the prootic, and the foramen, which lies above and slightly in advance of the supposed foramen for the carotis interna, is probably the foramen lacerum for the IXth–XIth nerves. On the dorsal side of this bridge of bone is a large irregular shaped opening which I take to be the fenestra ovalis and the opening for the VIIIth (auditory) nerve. Anterior to this and looking downwards and forwards is the large circular foramen ovale for the Vth (trigeminal) nerve.

Anterior to the foramen magnum the brain case heightens rapidly. Posteriorly it is considerably constricted and above the foramen ovalis the bone of the side-wall is pierced by a small circular opening, probably for a blood-vessel. Anterior to this the brain-case expands laterally and is bounded by the parietal above and the alisphenoid on the side — the two bones being divided by a straight horizontal suture.

The condition of the basicranium is somewhat similar to that seen in *Thecodontosaurus antiquus*, but differs in that the basisphenoidal tubera are placed further back and more ventrally in this new form, so that the lower surface of the basioccipital instead of passing almost entirely forward has a very concave profile when viewed from the side. The basisphenoid, too, differs in that it is longer in comparison with its width, neither the outward ridges of the bone which lead to the tubera nor the forwardly directed pterygoid apophyses diverging at so great an angle from each other as in the higher form.

The postpalatal vacuity lies directly below the orbits, and has a length of 26 mm., and a width of 9 mm. Almost the whole of its inner border, its anterior border, and part of its outer border are formed by the palatine. Its hinder border, and the remainder of the outer border is formed by the transpalatine.

The internal nares are not seen, but must have been considerably in advance of the postpalatal vacuity.

The anterior prolongation of the pterygoid passes far forward as a narrow bone with a rounded keel, separated from its neighbour by a well-marked groove. At the level of the front of the postpalatal vacuity it begins to broaden out and passes back as a gradually broadening plate articulating with, and lying below, the palatine. Posteriorly the mesial rounded keel becomes less pronounced and the platelike portion of the bone has a slight median depression.

The palatine is not wholly displayed. It articulates with the pterygoid internally, with the maxilla externally, and with the transpalatine posteriorly, forming the anterior and inner borders of the postpalatal vacuity. The front part of the bone carries a pronounced ridge which runs zig-zag across the bone with deep hollows in front and behind. There is no evidence that this ridge carried teeth.

The transpalatine is a stout bar with a strong expanded articulation with the maxilla externally. It separates the postpalatal vacuity from the large pterygoid vacuity; internally it is broken off, but the impression of the upper surface of the bone on the matrix remains in part, and it seems to have met both the palatine and the pterygoid.

Of the whole palate the premaxilla, maxilla, and prevomer form but a small part: in this, as pointed out in an earlier paper, the form agrees with *Erpetosuchus* and differs from *Ornithosuchus*.

The lower jaw is incomplete. About 100 mm. of the right ramus is anchylosed to the anterior 40 mm. of the left ramus, while a small portion of the back of the jaw is attached to the left quadrate. I am thus unfortunately unable to say whether or not a fossa was

present. Remnants of 12 teeth are preserved on the right dentary, and of 5 or 6 on the left. Of these latter the 4th is small and nearly complete. It shows that the teeth were flattened, pointed, and simple, provided with serrations on the anterior border. The dentary forms the whole of the anterior half of the outer surface and thickens in front to meet its neighbour over the whole of the symphysis. The splenial forms a large part of the inner surface of the anterior half of the jaw, but takes no part in the symphysis. It has a straight articulation with the dentary along the lower border of the jaw. The fractured end shows a small part of the angular lying within the splenial and dentary. There is a postarticular process passing behind the extremity of the quadrate.

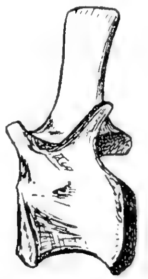


Fig. 13. *Sphenosuchus acutus*, Htn.
Anterior caudal vertebra. × 1.

Vertebrae. The anterior cervical vertebrae have been displaced and the centra are missing. The elements of the atlas cannot be distinguished, although a small curved bone lying on the right exoccipital is probably a part of the pro-atlas. The dorsal spine of the axis is preserved. It is 30 mm. long, higher in front than behind, and overlaps the 3rd. cervical. This latter shows well-developed, strong anterior zygapophyses, shorter postzygapophyses, a straight flattened dorsal spine, and a well-marked neural canal. The dorsal spines of the 4th and 5th cervicals are also present. They are like that of the 3rd cervical, slightly expanded at the crest, with a shallow groove running down the posterior border. The anterior ribs are double-headed.

There is an anterior caudal preserved (Text fig. 13). It is 16 mm. long and has a total height of 37 mm. The body is somewhat constricted in the middle, having a minimum width of 8 mm. The ventral surface is broadly rounded. The ventral border is concave with the posterior end lower than the anterior. The anterior surface

is concave. The posterior surface is concave in the middle, but its border slopes away to the edges of the surface so that its outer half is convex. There is thus a large surface for articulation with the haemapophysis below the concave portion of the posterior face of the centrum. The neural canal is circular in cross-section. The transverse processes rise high up and pass outwards, slightly upwards and slightly backwards. They are long, narrow, and thin. The zygapophyses diverge from each other strongly. The prezygapophyses have flat upper faces which look inwards. The neural spine is high

Fig. 14. *Sphenosuchus acutus*, Htn.
Internal view of left scapula. × 1.

and thin, narrower and higher than is usual in the Dinosauria or Crocodilia. Its base is broader posteriorly than anteriorly, and lies wholly in the hinder two-thirds of the neural arch. The width across the transverse processes is 30 mm.; that across the prezygapophyses is 12·5 mm.; the length of the upper border of the dorsal spine is 8 mm.

Shoulder girdle. The shoulder girdle is preserved entire, and consists of two scapulae, two coracoids and an interclavicle.

The scapula is 81 mm. long and expanded both at its proximal

and distal ends. The width of the distal end is 43 mm., of the proximal end 40 mm., while the narrowest part of the shaft — which occurs just above the proximal expansion — measures but 15 mm. in width. There is no acromion process.

The bone figured and described in the original paper as a clavicle is in reality a coracoid. The left coracoid is perfect save for the extreme distal point. The coracoid is a long, thin bone, whose shape can best be understood from the figure. The ventral margin is slightly convex and thin. Above this thin border the bone swells

Fig. 15. *Sphenosuchus acutus*, Htn.
Inner view of left coracoid. × 1.

and on the outer side there is a very slightly roughened elongated surface apparently for the insertion of the coraco-brachialis muscle. Above the interclavicular portion the anterior border is concave to a point directly below the coracoid notch, and then is again somewhat concave, the two curves being separated by a well-defined obtuse angle. The upper border of the post-glenoid prolongation is slightly concave. Anterior to what is apparently the scapular articular surface there is a small coracoid notch measuring only 2·5 mm. in diameter, and beyond this is a thin spatulate pre-glenoid prolongation with a length along its upper border of 11 mm. The greatest length of the bone is 77 mm. The width at the coracoid notch is 13 mm.; that at the broadest part of the postglenoid prolongation

is 14 mm. The length of the postglenoid process is 45 mm. while that of the interclavicular articular surface is 37 mm.

This coracoid differs from that of any known forms. In the Phytosauria the coracoid is rounded in form and has a large coracoid notch, and the pre-glenoid portion is much longer than the post-glenoid. In the Pseudosuchia the form is variable. *Ornithosuchus* has a rounded coracoid with a short posterior ventral process, and a supracoracoid foramen. *Euparkeria* has a large rounded coracoid. *Schleromochlus* has a long, flattened, rod-like coracoid like those of the Birds and Pterosauria. In the Crocodilia the coracoid approximates somewhat to that of *Sphenosuchus.* It also is composed of two expanded ends joined by a relatively narrow neck. But in the Crocodilia the bone is much higher and relatively shorter, and there is a foramen instead of a coracoid notch. This latter feature, however, is variable in the Crocodilia; for Andrews has figured two species of ***Metriorhynchus*** from the Oxford Clay, one of which has a coracoid notch and the other a coracoid foramen. In none of the Triassic Coelurosauria is the coracoid known; but in *Aetonyx* and other Triassic Saurischia it is a large rounded bone with a supracoracoid foramen, somewhat similar to that of *Euparkeria.* The South African form which most closely approximates to *Sphenosuchus* in this respect is ***Notochampsa.***

Humerus. The humerus is 113 mm. long. The proximal end is broad; in the inner view it is seen to be hollowed out between the delto-pectoral crest and a well-marked ridge which runs down on the inner side from the proximal condyle. The delto-pectoral crest lies considerably below the level of the head of the bone, so that the proximal expanded portion occupies two-fifths of the total length. The shaft is slightly curved, and oval in cross-section, the distal end being more strongly bent than the proximal. In the narrowest part the shaft has a diameter of 10 mm. The distal end is but slightly expanded and shows two distinct rounded condyles, of which the inner is much the larger. Seen in lateral aspect, the bone presents somewhat the appearance of that of *Ornithosuchus*, but it is longer, more slender, and the distal condyles are more rounded.

Tibia and ***Fibula.*** There is also preserved a tibia and the distal third of a fibula from the same limb. The tibia is a long, thin bone slightly curved, with an expanded proximal end, and a robust distal end. Its greatest length is 120 mm.; the distal end is 15 mm. wide, the shaft 9 mm., and the proximal end 29 mm. The tuberositas tibiae is the highest point of the bone. From it the articular

surface slopes downwards, gradually being rounded off into the posterior face of the bone. The inner edge of the proximal surface is evenly rounded; on the anterior half of the outer edge there is a prominent lateral condyle from which a short, prominent ridge passes down on to the shaft. This condyle lies well below the level of the head of the bone. At the distal end there is a differentiation into two processes, one of which lies higher than the other, as in the Triassic Saurischia; but the step from one to the other is not so deep as in, say, *Thecodontosaurus.*

A B

Fig. 16. *Sphenosuchus acutus*, Htn.
A. Inner view of left humerus.
B. Outer view of right humerus.
Both figures × ½.

The distal portion of the fibula shows the bone to have been more slender than the tibia. The distal end is slightly expanded. The bone is oval in cross-section.

Type. Skull and part of lower jaw with bones of the shoulder girdle, part of fore limbs, and part of hind limb, with vertebrae and rib fragments. (S.A.Mus. Cat. No. 3014.)

Locality. Paballong, Mount Fletcher, Cape Colony.

Horizon. Red Beds.

Affinities. In the general form of the skull *Sphenosuchus* agrees with most of the members of the super-order Archosauria, i.e. in the possession of supra-, infra-, and post-temporal arcades and vacuities.

In some Dinosaurs the post-temporal vacuity is closed. In *Sphenosuchus* it is very small, much smaller than in the Phytosauria or genera like *Euparkeria.*

The skull has a smaller quadrato-jugal than *Euparkeria*, but shows an advance on that form in the loss of the interparietal and the reduction of the lachrymal.

Chief interest lies, however, in the post-cranial part of the skeleton and in the lack of armour. This latter feature is noteworthy as the larger number of the genera comprising the order Thecodontia, to which this form was originally assigned, possess armour in the form of scutes which are sometimes numerous and heavy. No armour has, however, yet been seen in *Thecodontosaurus*, *Massospondylus*, and the genera of the Saurischia.

The shape of the coracoid (erroneously described in the original description as the clavicle) is unique among reptiles, and strongly resembles that of many Birds. Among Reptiles, it is approximated most closely by the bones in *Notochampsa* and the Crocodilia. *Euparkeria* has a rounded coracoid, and so has *Massospondylus*, so that *Sphenosuchus* cannot be ancestral to the latter nor to the Saurischia. Its humerus and tibia, however, are more like those of the Saurischia and *Massospondylus* and its allies than other Archosauria; and the shape of the distal end of the tibia shows that the astragalus was probably fairly immovably fixed to the tibia. Further, the possible lack of clavicles is important. The other bones of the scapular arch are so well preserved and so nearly in place that it is scarcely possible to suppose that bony clavicles, if present in the living animal, were not preserved. Lying anterior to the arch and dissociated from the scapula and coracoid is a thin elongate bone — not complete — which might be a clavicle or a neck rib or even a long bone of the hyoid arch similar to the ceratobranchial described by Broom in *Euparkeria.* The absence of clavicles would remove the form altogether from the order Thecodontia. Further, it could only be put with difficulty into the Saurischia on account of its peculiarly specialised coracoid, which must be taken as a proof of a certain similarity in musculature between this form and the Birds. On the other hand, the coracoid is more elongate and birdlike than that of *Archaeopteryx*, which has already acquired feathers; and it is probable that this peculiarity in the coracoid of *Sphenosuchus* is merely a specialisation which was not a step on an advance from the Reptile to the Bird. The absence of clavicles would prevent *Sphenosuchus* from being on the direct line of evolution of the class Aves.

Taking all the facts into consideration, it is necessary to found

for the genus a new family, which may be called the *Sphenosuchidae*, and which on account of the uncertainty as to the occurrence or absence of clavicles, cannot be satisfactorily included in any of the defined orders of the Archosauria.

Fam. NOTOCHAMPSIDAE, nov.

Notochampsa istedana, Broom.

Text fig. 17, 18.

1904. Broom. Geol. Mag. Dec. V, Vol. I, p. 502.

The only hitherto-published description of *Notochampsa* is that by Broom who gave a very brief notice of the two forms from the Stormberg Beds which he included in the genus. At the time of writing that paper, the remains of the larger animal (*N. istedana*) had not been completely developed, but Broom considered that enough was shown to place the forms in the Crocodilia (Mesosuchia of Huxley). A short time ago Watson suggested that the larger form was possibly not a crocodile at all, but was related to *Stegomus*. I have therefore further developed the fossil in the hope that it would be possible to settle its systematic position. There are now displayed the impressions of most of the bones of the top of the skull, most of the right ramus of the lower jaw with the whole symphysis, the shoulder girdle (right scapula, two coracoids, and an interclavicle), the proximal end of the right humerus, the humerus, radius, ulna, carpus, and metacarpus of the left side, part of the femur, tibia, and fibula of the left side, most of the dorsal armour, and some ribs. These remains merit a somewhat fuller description than that already given.

Skull. Unfortunately, although further development has shown a little more of the top of the skull, nothing can be seen of the structure of the palate.

In the middle line, as preserved, the skull has a length of 101·5 mm., while its greatest length is 117 mm. The length of the lower jaw from the symphysis to the articular surface is only 106 mm. Little, therefore, can be missing from the front of the snout although the anterior borders of the nares are not seen. The nares must, in consequence, have been almost terminal. In his restoration of the skull Broom figures the nares as being typically crocodilian, i.e., coalesced into one central opening in the premaxilla, and thus adds about 14 mm. to the length of skull as preserved. This, I think, is a misinterpretation of the structure because, in the first place, the disparity in length between the mandible and skull becomes too

great and, secondly, there seems to be sufficient evidence in the nasal region itself to prove that the nostrils were separate and somewhat lateral. The whole structure of the remaining portion of the snout seems to point to this conclusion. On the righthand side the im-

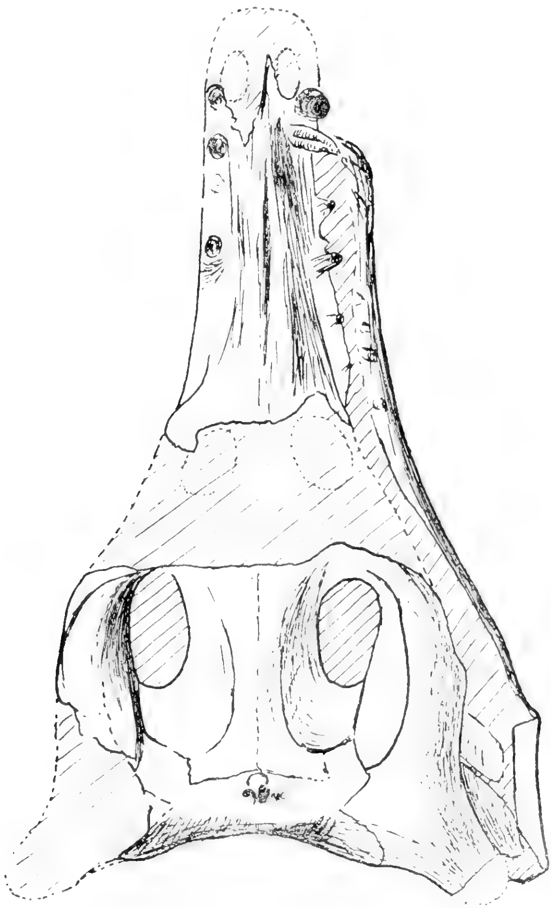


Fig. 17. *Notochampsa istedana*, Br.
Top view of skull. × 1.

pression of the bone is excavated as if it were the posterior border of the nostril. This portion of the snout seen in profile is distinctly raised, whereas the remainder of the snout is slightly concave along the median line, and between the nostril and the centre line is a shallow concavity. If this reading of the structure is correct, then

the nostrils were somewhat laterally placed and separate as in the Pseudosuchia. It demands an additional length of about 5 mm. to the tip of the snout, thus making the upper and lower jaws more commensurate than does the earlier restoration.

The snout is fairly long, and tapers slightly anteriorly. Most of its upper surface is formed by the nasals, which are separated by a long median suture, and terminate behind in a digitating suture with the frontals.

The maxilla bears a number of teeth, about 8 or 9 in all probability. The first two preserved on the right maxilla are large teeth with long roots each set in its own socket, and with backwardly-curved pointed crowns somewhat oval in section. There were no prominent anterior or posterior edges. The posterior teeth were smaller than the others, but there is no regular diminution in size.

The snout is broken off anterior to the orbits, and the whole of the orbital region is missing. Just anterior to the hiatus the snout swells laterally and becomes raised on the two sides, the median depression remaining constant. The lateral prominences look to be each the impression of a separate bone, although sutures are extremely difficult to delineate. Each contains a portion of the bone figured by Broom as lachrymal, and each is probably wholly a prefrontal. If this be so, the lachrymal was wholly on the side of the skull.

Only the impressions of the lower surface of the bones surrounding the vacuity are present.

The upper temporal vacuities are present. Their anterior borders are formed by the postorbitals. Broom figures the squamosal as forming the whole of the bar between the upper and lower temporal fossae; but on the right hand side there is a well-marked separation between the bone forming the inner part and that forming the outer part of this bar, and the separation is seen also in part on the left hand side of the skull. The inner of the bones I take to be the upper portion of the quadrate, which just meets the postorbital anteriorly, and has the relations of the quadrate in the recent Crocodilia. Externally and posteriorly it articulates with the squamosal.

The squamosal also passes outwards, backwards, and downwards to form the posterior border of the lower temporal vacuity and to meet the quadrate. On the inner side it meets the supraoccipital and exoccipital.

The parietal bar is very broad.

The quadrate is partially displayed. The form of its articular surface is not seen. The inner edge of the bone is bent upwards to meet the squamosal; and its other relations have been stated above.

The lateral temporal opening was long and fairly low. In it can be seen a portion of the quadrato-jugal, lacking the outer edge, and articulating with the quadrate.

The supraoccipital articulates above with the parietal in a fairly long suture. Ventrally it narrows rapidly and articulates on its oblique edges with the exoccipitals, which are apparently large bones.

The weathering away of the bone shows a canal opening into the auditory region between the quadrate and the parietal on the posterior border of the upper temporal opening, and this is continued into the post-temporal vacuity, bounded by the squamosal and parietal above and the exoccipital and supraoccipital below.

Mandible. Part of the lower jaw is preserved. The symphysis is fairly short, and formed apparently wholly by the dentaries. The lower jaw is slender, its deepest part being just behind the Meckelian cavity.

Of the right ramus, the dentary is wholly preserved. It meets its neighbour in a symphysis 12 mm. long. The alveolar border is straight and carries about 12 teeth of which 9 can be seen. The first two are in the position of incisors and point strongly forwards. The third is considerably larger than any of the others. Posterior to it the teeth seem to be of approximately equal size to one another. At the level of the last three or four teeth the dentary is extremely shallow, while it broadens again towards the Meckelian cavity, of which it forms the anterior half of the border. The ventral face of the symphysial region is convex from side to side, and pitted.

The splenials are not preserved; but the shape of the inner surface of the right dentary shows their approximate positions. The bone did not enter the symphysis. For over one-half its length it lay along the inside of the dentary. For a distance of 18 mm. it was separated from the dentary by the angular, lying along the inner surface of that bone almost to the level of the outer fossa.

The angular has relations with the other bones, as far as can be seen, similar to those in the Crocodilia. It forms the posterior border of the outer fossa, and passes on the ventral side below the dentary, separating it from the splenial. None of the other bones are seen.

Scapula. The right scapula is displayed in full, as well as the glenoid end of the left scapula. The bone is extraordinarily expanded at its upper end, and somewhat swollen below. The posterior border from the narrowest part of the bone upwards is almost straight, save at the upper extremity; but the anterior edge is strongly bent owing to the anterior prolongation of the upper part of the bone. The lower part of its anterior border is swollen and convex,

while the articulation with the coracoidal element is almost straight. Approximately half the glenoid cavity is formed by the scapula. From the narrowest part upwards the bone is very thin. From the upper posterior corner to the middle of the glenoid cavity the scapula measures 43 mm. At its narrowest it is 4·5 mm. wide; at its upper border it is 30 mm. wide. The articulation with the coracoid measures 8·5 mm.

Coracoid. Both coracoids are seen. The bone is smaller than the scapula, strongly compressed and expanding considerably at each end.

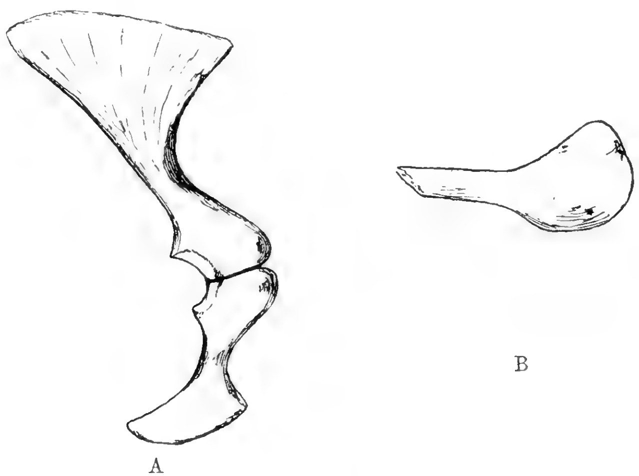


Fig. 18. *Notochampsa istedana*, Br.
A. Scapula and coracoid.
B. Proximal half of humerus.

It forms the lower half of the glenoid cavity. Anterior to the glenoid cavity and just below the articulation with the scapula the bone is pierced by the coracoidal foramen. The distal expansion is very broad, terminates in a convex border and is prolonged more posteriorly than anteriorly.

The coracoid has a length of 25 mm. in the middle line. Its lower border measures 15 mm., while its narrowest part has a width of only 3 mm.

The ***Interclavicle*** is a narrow elongated strip of bone, not wholly preserved.

Humerus. The humerus has a long, thin, flattened shaft with a considerably expanded upper end. The lower end is not preserved on either side of the body. The total length of the bone was probably

about 60 mm. The maximum width at the proximal end is 14 mm., while the shaft is 4 mm. broad and 1·5 mm. thick as preserved. The head is rounded, and there is no very prominent deltoid crest although some distance below the head of the bone a slight crest was present. The anterior face of the expanded portion is concave.

The *radius* and *ulna* are both long, slender bones but slightly expanded at their ends. The bone lying as the outer of the two on the left-hand side of the body is slightly longer than the other, and this I take to be the ulna. The left forearm is lying parallel to the body with the elbow behind and the hand in front, bent almost at an angle of 150° to the plane of the humerus.

Radius. The radius has a length of 52 mm., while the middle of the shaft has a greater diameter of 2·5 mm. The bone is compressed and has its end expanded to a width of about 4 mm. Save at the lower end, where it is slightly curved away from the ulna, it is straight throughout its length.

Ulna. The ulna is a slightly curved bone 54 mm. long, apparently somewhat more slender than the radius, but with similar expanded ends. Just below the surface for the articulation with the humerus the radial border is markedly concave.

Carpus. The carpus of the left side is partially displayed. Two bones of the proximal row can be seen, one below the ulna and one below the radius. These I regard respectively as the ulnare and the radiale.

The *ulnare* is an elongated bone with a narrow shaft and expanded ends. In cross-section it is apparently oval. Its length is 10 mm., the proximal width 4 mm., and the distal width 5 mm., while the shaft of the bone has a width in its narrowest part of less than 2 mm. The proximal articular surface has a small outer convexity, the remainder being hollowed out. The distal surface is cushion-shaped. Attached to the lower end of the bone is a small bone, oval in section as seen, 2 mm. high and 4 mm. broad, which may be the fused 3rd, 4th, and 5th carpals. The *radiale* is a similar hour-glass shaped bone 11·5 mm. long with its ends somewhat less expanded than those of the ulnare. The narrowest part of the bone is 2 mm. wide.

Metacarpus. Remains of all five metacarpals are seen. The third and fourth articulate with the bone lying below the ulnare, but not the fifth. Each metacarpal is an elongated bone with expanded ends. The first is 9·7 mm. long, the second 10 mm., the third 9·5 mm. and the fourth 8·3 mm., while the fifth is not fully displayed.

Femur. The distal half of the femur is slightly curved and has

an expanded end, which was probably slightly cartilaginous. The preserved portion of the bone is 48 mm. long, and the distal end measures 11·5 mm. in its greatest diameter. The shaft at its narrowest is between 5 and 6 mm. thick. The outer condyle is larger than the inner and on the anterior surface between the two is a shallow, broad depression.

The *tibia* and *fibula* are both long, slender bones, longer and more robust, however, than the bones of the lower part of the fore-leg. The *tibia* has a length of 62 mm. Its shaft is long and straight; the proximal end of the bone is swollen to a thickness of 6·5 mm., and rounded. The distal end is somewhat crushed, but it is wider than the proximal end and has a protuberance on the fibular side. The *fibula* is a more slender bone, 60 mm. long, with slightly expanded ends.

Armour. The back was covered with a series of paired dorsal scutes, one of which was figured by Broom. There were apparently neither lateral nor ventral ossifications — at least, none are preserved on this specimen. Each pair of scutes covered one vertebra. Remains of 20 pairs are preserved, almost wholly as impressions of the under surface of the bone. Each scute was roughly rectangular, but towards the outer end of the posterior border there was a projecting process. From the twelfth pair onwards the width gradually decreases. The first scute is short, the second slightly longer. The 3rd is a little longer than the 4th or 5th. From this onwards the length is constant. The 11th. scute is 20 mm. broad and 9·5 mm. long at its inner edge. The 19th. has a breadth of 14·5 mm. and a length of 9 mm.

Affinities. In the elongation of the rostrum the form agrees with the Crocodilia and Phytosauria; but in the possession of paired and lateral outer nares it differs from the former, and in the short premaxillary and forward position of the nostrils from the latter. The elongation of the rostrum is a secondary character.

I am not able to determine with absolute satisfaction whether or not a preorbital vacuity was present. The orbit itself is absent, but both prefrontals can be seen. On the right hand side below the prefrontal on the side of the skull there is a distinct depression with superior, anterior, and inferior borders of bone. This may — and probably does — represent a preorbital vacuity, looking wholly outwards and placed below the orbit and but slightly in advance of it, a condition paralleled to a certain extent in the Phytosaurians *Mystriosuchus* and *Rhytidodon.*

The scapula is without parallel among Archosauria in the extreme

broadening of its dorsal half. The coracoid has the general shape seen in the Crodilia; but an even greater departure from the rounded bone of the Pseudosuchia and Phytosauria is presented by the coracoid of *Sphenosuchus*, described in this paper, which is undoubtedly a Pseudosuchian of rather advanced type. In the possession of an interclavicle and the absence of clavicles *Notochampsa* agrees with the Crocodilia and differs from the Dinosauria, Phytosauria, and earlier Pseudosuchia.

The fore-limb is not Crocodilian in structure. The humerus in its expanded proximal portion with concave anterior surface, its deltopectoral crest well below the level of the head of the bone, and its narrow shaft is reminiscent of that of *Stagonolepis* which, however, departs from the normal Phytosaurian form and approximates to that of the Pseudosuchia and Saurischia.

The long and slender limbs show affinities with such forms as *Stegomus* and *Schleromochlus*, although the front limb approximates in length to that of the hind limb much more nearly than in the latter form. The genus herein differs greatly from the Jurassic Crocodilia.

The armour is peculiar in that it apparently consists only of two rows of scutes along the back. These are broader than long as in *Stegomus*, *Aetosaurus* and *Dyoplax*. Possibly, however, ventral armour was also present.

With the form described as *Pedeticosaurus leviseuri* by van Hoepen *Notochampsa* possesses several characters in common. Both have the snout somewhat elongate, with the nostrils separate, lateral, and nearly terminal. Both have thecodont teeth, of which the two just behind the premaxilla seem to be the longest and strongest. In *Pedeticosaurus* there is a small antorbital vacuity on the side of the face — smaller than in other Pseudosuchia — an arrangement which may, as stated above, be present in *Notochampsa*. There is also a general agreement between the two forms in the broadened distal end of the scapula, the long and slender bones of the upper arm and fore-arm, the elongate carpals, the comparatively short ribs, and the double row of plates down the back. The bone called by van Hoepen the left scapula appears to be more likely to be a coracoid. If that be so, it will agree with the coracoids of *Notochampsa* in its general shape, having two expanded ends connected by a narrower shaft. The hind leg in *Pedeticosaurus* is relatively somewhat longer than in *Notochampsa*.

The points of agreement are, I think, sufficiently numerous provisionally to place the two genera *Notochampsa* and *Pedeticosaurus* in the same family which must be called the *Notochampsidae*. This

displays affinities both with the Pseudosuchia and the Crocodilia.

By von Huene the Crocodilia are thought to have been derived directly from the Aetosauria. Such a descent implies, among other things, elongation of the snout, the loss of preorbital vacuity, the loss of the clavicles, and the production of a typically Crocodilian coracoid. These changes are partly brought about and partly foreshadowed in the Notochampsidae; and although the limbs are not modified in the Crocodilian manner save in the lengthening of the carpals, it may be concluded with some degree of truth that the family occupies an intermediate position between the Aetosauria and the Crocodilia, possibly on the direct line of descent. It is unfortunate that nothing is known of the palate in either of the two members of the family.

Type. Skull and portion of skeleton and armour. (S. A. Mus. Cat. No. 4013).

Locality. Funnystone, Barkly East, C.P.

Horizon. Cave Sandstone.

Pedeticosaurus leviseuri v. Hoepen.

1915. van Hoepen. Ann. Transv. Mus. V, p. 83. Pls. XIII–XIV.

The type consists "of a nearly complete individual on two slabs of matrix. The fossil is an impression of the right side of the skull and limbs, and besides this, consists of some vertebrae, a few ribs, a great part of the tail and of dermal ossifications".

The skull is only seen in lateral view. It has a total length of abouth 90 mm. The snout is low and fairly long, the front of the orbit lying a little in advance of the middle of the skull. The orbit is large and rounded, the antorbital vacuity small with a straight lower border. The nostrils are almost terminal. The bar separating the upper and lower temporal vacuities is not clearly displayed. The lower border of the lower opening is formed mainly by a shallow jugal. Posteriorly this meets a bone, which, as preserved, has a free upper anterior end, and occupies the same position as the bone which I have called quadratojugal in *Notochampsa* and *Sphenosuchus.* Behind this is a portion of the quadrate with which the lower jaw still articulates.

The premaxilla carries three small teeth; the maxilla probably carries 16 or 17 teeth, of which the anterior two or three are large. All are pointed, backwardly curved, aud apparently unserrate.

The bone which van Hoepen has called a "hyoid" is apparently a double-headed anterior cervical rib.

The account given by van Hoepen of the post-cranial skeleton is correct save that the bone which he describes as the less-completely preserved scapula I take to be a coracoid, elongate in shape somewhat similar to that seen in the Crocodilia and in *Notochampsa.* It is also possible that the small fragment lying above the supposed coracoid and below the humerus of the other side is the impression of part of a small straight interclavicle. The assumption of the presence of a coracoid is justified by the long straight distal articular surface of the scapula lying anterior to the glenoid cavity; this is equal in length to the articular surface of the supposed coracoid, which has a comparatively narrow middle portion with strongly expanded ends.

If a coracoid be truly present, then an interesting comparison can be drawn between *Pedeticosaurus* and *Notochampsa*, as I have pointed out in the re-description of the latter form. *Pedeticosaurus* is a slightly smaller animal having, however, its hind legs longer and more strongly developed than those of *Notochampsa.* The resemblances are close enough to suggest a family connection, and I have therefore placed both genera in the same family.

I have to thank Mr. M. Leviseur and the Bloemfontein Museum authorities for permission to examine the type.

Type. Incomplete skeleton on two slabs in the Orange Free State Museum.

Locality. Rosendal, Senekal Distr., Orange Free State.

Horizon. Cave Sandstone.

Order CROCODILIA (?).

Erythrochampsa nov.

Erythrochampsa longipes (Broom).

1904. Broom. *Notochampsa longipes.* Geol. Mag. N. S. Dec. V. Vol. I. p. 582, figs. 2 and 4.

Pelvis. In his original description of this form, Broom says "the pelvis is typically Crocodilian in that the pubis does not enter the acetabulum. The ilium is of small size."

The pelvis as preserved is seen partly on the main slab and partly on a small piece of rock which was broken off in the development of the fossil for the purpose of examining the pelvis. This latter shows the two ischia, most of the two prepubes, and a portion of the left ilium (partly in bone and partly as a mould). The main slab shows moulds of these bones with small pieces of bone adhering.

The *ilium* is incomplete. It was a stout bone, nearly as large as

the ischium, with a long dorsal border. There is a long pre-acetabular portion with a bluntly-pointed extremity.

The *ischium* is of the usual Crocodilian form. Ventrally it forms a long union with its fellow by means of a straight suture 15 mm. long. The ventral portion of the bone is a triangular plate with an acute posterior angle and a more obtuse anterior angle. The dorsal portion of the bone is bifurcated, with a larger posterior portion for articulation with the ilium, and a prominent anterior protuberance directed upwards and forwards for articulation with the unossified pubis.

On neither side is the prepubis complete. Each is a slender bone with a spatulate anterior portion. The two bones do not meet ventrally and must have been connected by cartilage. The proximal end is slightly expanded and lies at present some distance in front of the ischium and wholly disconnected from it. The length was 23·5 mm., and the greatest breadth at the spatulate end 4·5 mm., while at its narrowest the shaft is just under 1·5 mm. broad. The shaft is nearly circular in cross-section.

Femur. The right femur is partially preserved. It consists of a slightly bent shaft with somewhat swollen ends. The ends of the bone are spongy while the shaft is hollow — a condition which is seen in the other bones of the hind limb and the pelvis. The length is about 48 mm. The head is 4·3 mm. broad, the shaft 3·8 mm. In cross-section the shaft is a somewhat flattened oval. The distal end has two condyles separated by a well-marked intercondylar groove. The outer condyle is larger than the inner. The width of the distal end is 8 mm.

Tibia. The tibia is 4 or 5 mm. shorter than the femur. It is a very slightly curved shaft with an expanded proximal end flattened antero-posteriorly. The fibular side of the shaft is somewhat flattened, while the inner side is regularly curved. Distally the bone widens out. The breadth of the proximal end is 6 mm., while the width of the shaft is 3·5 mm.

Fibula. The fibula is approximately of the same length as the tibia, but is a much more slender bone. Between the shaft and the proximal end there is a narrow neck. The shaft has a longitudinal ridge on the inner anterior border. The distal end is not seen. The shaft is 2 mm. broad.

Tarsus. The structure of the tarsus is somewhat difficult of determination. The cleavage of the rock has broken the bones across the middle so that neither the dorsal nor palmar surfaces are seen. The *astragalus* is much larger than the *calcaneum*, which is a small bone with a small posterior tuber joined to the main body of the

bone by a narrow neck. There are two other bones of which the one articulating with the calcaneum may be the cuboid and the other the reduced fifth metatarsal or the fused 4th and 5th tarsalia.

Metatarsus. Metatarsals I — IV are similarly elongated narrow cylindrical bones with slightly expanded ends. The 2nd and 3rd are larger than the others, while the 4th is the shortest. The lengths from the 1st to the 4th are 22 mm., 23 mm., 23 mm.. and 20 mm. respectively.

One phalanx of the 2nd. digit and two phalanges of the third are preserved. Each is a fairly long slender bone with concave proximal and convex distal articulation.

Armour. Portions of the dorsal and ventral armour are preserved. One of the dorsal plates has been figured by Dr. Broom. It has a width of 13 mm., and a length of 8 mm. in the middle line. Its dorsal surface is pitted save for the portion overlapped by the anterior plate. At the outer sixth the plate is bent downwards, the bend being strengthened by a dorsal ridge. The total width of the body was probably about 25 mm. The ventral plates are paired, but are smaller and more numerous than the dorsal plates. In the abdominal region each was about 9 mm. wide and 4 mm. long, while in the caudal region they were smaller.

The two forms described by Dr. Broom as *Notochampsa* were included in the one genus on account of resemblances between the dorsal plates. Further investigation shows that while the pelvis in "*N. longipes*" is typically Crocodilian the skull of *N. istedana* shows features which remove it from the true crocodiles. The question then arises, are the two forms congeneric? Dorsal plates are known, not only in the Crocodilia, but in the Pseudosuchia such as *Schleromochlus*, *Aetosaurus*, and *Euparkeria*; and it is doubtful whether they can be considered of generic importance. Unfortunately the pelvis is absent in the type of *N. istedana* and also in the allied type *Pedeticosaurus*. If Broom's *N. longipes* is to be kept in the genus *Notochampsa* then the genus must be considered to be characterised by the possession of a skull differing from that of a true Crocodile and of a typically Crocodilian pelvis. This is not impossible; but until more is known of these forms it would seem best to separate the two forms from one another, classing *istedana* as one of the higher Pseudosuchians and erecting, as above, a new genus *Erythrochampsa* for the more truly Crocodilian *Erythrochampsa longipes*.

Type. S. Af. Mus. N⁰. 445 f.

Locality. Eagles Crag, Barkly East, C. P.

Horizon. Red Beds.

Fam. THECODONTOSAURIDAE von Huene.

1905. von Huene. Zeitschr. d. dtsch. geol. Ges. LVII, p. 345.

Thecodontosaurus browni (Seeley).

1895. Seeley. ***Massospondylus* (?) *browni***, Ann. Mag. Nat. Hist., Ser. VI, vol. 15, pp. 102–132.

1906. von Huene. Geol. u. Pal. Abh. XII, 2, p. 45, figs. 82–85, Pl. XII (XIX), figs. 7–8.

1911. Broom. Ann. S. Afric. Mus. VII, 4, p. 293.

The type consists of two femora, 2 cervical vertebrae, a dorsal vertebra, 3 caudal vertebrae, and some foot-bones from the Telle River, separating Herschel from Basutoland. There is some doubt as to whether all the remains are from the same animal, and von Huene in his re-description has classed the vertebrae with *Thecodontosaurus skirtopodus.* From von Huene's account, the following are taken as the salient points of the form.

The femur is small, markedly S-shaped, with a compressed distal end and a sagittal groove which divides the articular surface. The bone is strongly compressed laterally. The fourth trochanter lies wholly in the upper half of the bone. The head is rounded and very thick. The length of the type is 24 cm.

Von Huene notes that the femur is as large as that of *Thecodontosaurus cylindrodon*, but at the distal end is smaller and has higher and smaller condyles than *T. skirtopodus.* The proximal end is smaller and thicker than in *T. antiquus* and *T. cylindrodon.*

Van Hoepen has described under the name of *Massospondylus browni* a fairly complete skeleton in the Transvaal Museum. I believe this to be a specimen of *Massospondylus harriesi* and have discussed it in my description of that form.

Type. Isolated bones in the British Museum.

Locality. Telle River, Herschel, C. P.

Horizon. Red Beds.

Thecodontosaurus skirtopodus (Seeley).

Text figs. 19, 20.

1894. Seeley. *Hortalotarsus skirtopodus.* Ann. Mag. Nat. Hist. (6). Vol. XIV, p. 411–419.

1906. von Huene. *Thecodontosaurus skirtopodus.* Geol. u. Palaeont. Abh. N. F. Bd. VIII, Hft. 2, p. 44, figs. 72–78. Pls. XII, XIII.

The type is a portion of a hind limb from Barkly East. Von

Huene has also described some vertebrae, humeri, a femur, and a tibia from "the Karroo formation" — now in the Vienna Museum — as members of this species.

Discussing the generic position of the form von Huene says "The form of the tibia is entirely characteristic of ***Thecodontosaurus***; the long, laterally-directed projection at the proximal end, the broad lateral condyle at the proximal end, and the nature of the expansion of the proximal and distal ends are elsewhere only seen in ***Thecodontosaurus*** and *Anchisaurus*. The astragalus, also, corresponds closely with that of *Thecodontosaurus* from Bristol. I can see no ground for separating ***Hortalotarsus*** from *Thecodontosaurus*."

While collecting at Foutanie, Fouriesburg, O. F. S., Mr. A. R.

Fig. 19. *Thecodontosaurus skirtopodus* (Seeley). Right ulna. × ½.

Walker obtained some bones from the top of the Red Beds. They comprise (S. A. M., Cat. No. 3429) some vertebrae, a scapula, the distal end of a humerus, an ulna, an ilium, part of an ischium, a femur and a tibia which belong to an animal somewhat smaller than, but closely comparable with, the type of ***T. skirtopodus***. The bones are in good condition and worthy of a short description, especially as some portions of the skeleton were hitherto unknown.

Scapula. The right scapula is almost complete. Its length as preserved is 125 mm., but it lacks the distal end. It is small and slender, the minimum width across the bone being 21 mm. Distally the shaft expands very slightly, but proximally it has a greatest width of 47 mm. The proximal portion is very like that of ***Massospondylus carinatus***. On the lateral face the supracoracoidal surface is concave. The whole bone is curved in its length, convex out-

wards. At the glenoid cavity the bone has a thickness of 17 mm. Both the anterior and posterior borders of the blade are fairly thin and keeled, but proximally the anterior border becomes thicker and more rounded.

Ulna. The right ulna is complete. Its length is 87 mm. The proximal articular surface is triangular with an acute rounded anterior angle, and an obtuse lateral angle. The posterior end stands higher than the anterior. Below the proximal end the bone narrows rapidly. In its proximal half the medial face of the bone has a shallow broad longitudinal groove. Distally the bone is twisted and flattened so that the broad faces of the distal end look directly forwards and backwards. The distal end is 19 mm. broad. The medial end of the articular surface is pointed, the lateral end truncate. The

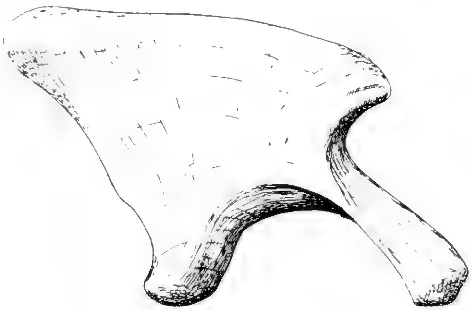


Fig. 20. *Thecodontosaurus skirtopodus* (Seeley). Right ilium.

maximum thickness at this surface is 11 mm. At its thinnest the shaft is 12 mm. broad and 7 mm. thick.

Ilium. The right ilium is typically Thecodontosaurian with its short anterior spine and its elongate posterior spine. The length of the upper border is 105 mm.; the border is slightly curved, more so anteriorly than posteriorly. The posterior spine is more pointed than in *T. antiquus.* On its inner surface the inner crest is strongly developed. The acetabulum is 60 mm. broad and 30 mm. high. The supra-acetabular crest is strongly developed above the anterior part, but disappears posteriorly. The height from the postacetabular process to the upper border of the bone is 76 mm. The preacetabular process is 48 mm. long.

Ischium. The distal end of a left ischium is 117 mm. long. The shaft is slender, strongly expanded distally. The anterior edge is straight and sharp, the posterior border regularly concave and flattened.

The bone was in contact with its fellow for a length of about 80 mm. At the bottom of the groove on the posterior surface the bone is 17 mm. thick from back to front. At the distal end the maximum thickness is 29 mm.

Femur. The distal portion of a right femur is complete from the trochanter quartus downwards. The distal end agrees closely with that figured by von Huene in its general contours, its compression sharply marking it off from *Massospondylus carinatus.* The length from the bottom of the fourth trochanter to the distal end is 105 mm. Both condyles are high; at the lateral condyle the distal surface is at its broadest. There is a deep, narrow groove between the condyles on the posterior surface. The minimum breadth of the shaft is 24 mm. The length of the distal articular surface is 39 mm., its breadth at the lateral condyle 34 mm., and at the medial condyle 29 mm.

Tibia. The tibia is complete save for the proximal articular surface. The length is 174 mm. The bone seems slightly crushed, so that the medial edge of tbe proximal end is not very convex. The medial condyle lies nearer the posterior end of the surface. Behind the anterior point the lateral border is somewhat concave. The shaft is flattened laterally and has a minimum thickness of 35 mm., and a minimum breadth of 11 mm. At the distal end the bone is broader in front than behind, the breadths being 31 mm. and 17 mm. respectively. The anterior condyle lies 13 mm. above the posterior.

Discussing the relations of this species with European members of the genus von Huene says *Thecodontosaurns skirtopodus* has somewhat shorter dorsal vertebrae than *T. antiquus*, the cross-section being the same. The humerus is of similar size to *T. antiquus*, but the processus lateralis reaches much deeper here than there. A bone, which is doubtless the end of the ischium, agrees with a similar bone in *T. antiquus* and differs considerably from *T. polyzelus.* The distal end of the femur is smaller and thicker than in *T. antiquus* and *T. cylindrodon*, and the condyles are higher than in *T. polyzelus.* The length of the tibia agrees with that of *T. MacGillivrayi*; the proximal end is tolerably small, the lower half of the shaft and distal end thicker than in *T. antiquus.* The astragalus is as in *T. antiquus.* Metatarsal IV corresponds best with *T. polyzelus.*

Type. Portion of hind limb in British Museum.

Locality. Barkly East Division, C.P.

Horizon. Cave Santstone.

THECODONTOSAURUS MINOR Htn.

Text fig. 21.

1918. Haughton. Ann. Mag. Nat. Hist. IX, II, p. 468.

"The specimens forming the type of this new form were presented to the South African Museum by the late Dr. M. Ricono. They consist of a left tibia, a cervical vertebra, and a portion of the left ilium.

Left tibia. The tibia is 109 mm. long. The proximal articular surface is 31 mm. long, and 18 mm. broad. This surface for the most part slopes obliquely backwards and laterally, the inner border being convex from front to back and higher in front than behind. The tuberositas tibiae is almost the highest point of the bone; it is prolonged anteriorly and turned slightly outwards. The lateral condyle is strongly developed. Below the head the shaft thins rapidly until at its middle it has an anteroposterior thickness of 12 mm., and a width of 10 mm. Thence it thickens towards the distal end. The anterior face is flat with a prominent edge on the lateral side and a rounded edge medially. The outer sharp edge is continued down to the anterior distal process. The posterior border of the shaft is rounded.

The distal surface is trapezoidal in form. The inner anterior border is 20.5 mm. long, the posterior outer border 16 mm. long, while the posterior inner border is 12 mm. long. The anterior process lies 7 mm. above the posterior process. Between the two on the outer surface of the bone is a shallow groove.

Cervical vertebra. The length of the body is 31 mm. The anterior articular surface is slightly larger than the posterior. Both are considerably higher than broad. The body is pronouncedly amphicoelous. There is a prominent median ventral keel, sharper in its anterior half. The whole body is strongly compressed laterally, having a width at the middle of 5 mm.. and the anterior end of 8 mm. The canal has a height and breadth anteriorly each of 5 mm. The ends of the zygapophyses are missing. The dorsal spine was low and fairly long with a somewhat convex upper border.

Ischium. A portion of what is probably the left ischium is preserved, including the proximal articular surface. The bone is bent strongly backwards, more so than in *Thecodontosaurus antiquus* as figured by von Huene, so that the ischium must have been directed very strongly backwards. At the broken distal end the bone is 12 mm. thick, and 6·5 mm. broad. The inner border of the proximal surface is straight, the lateral border has a prominent outward

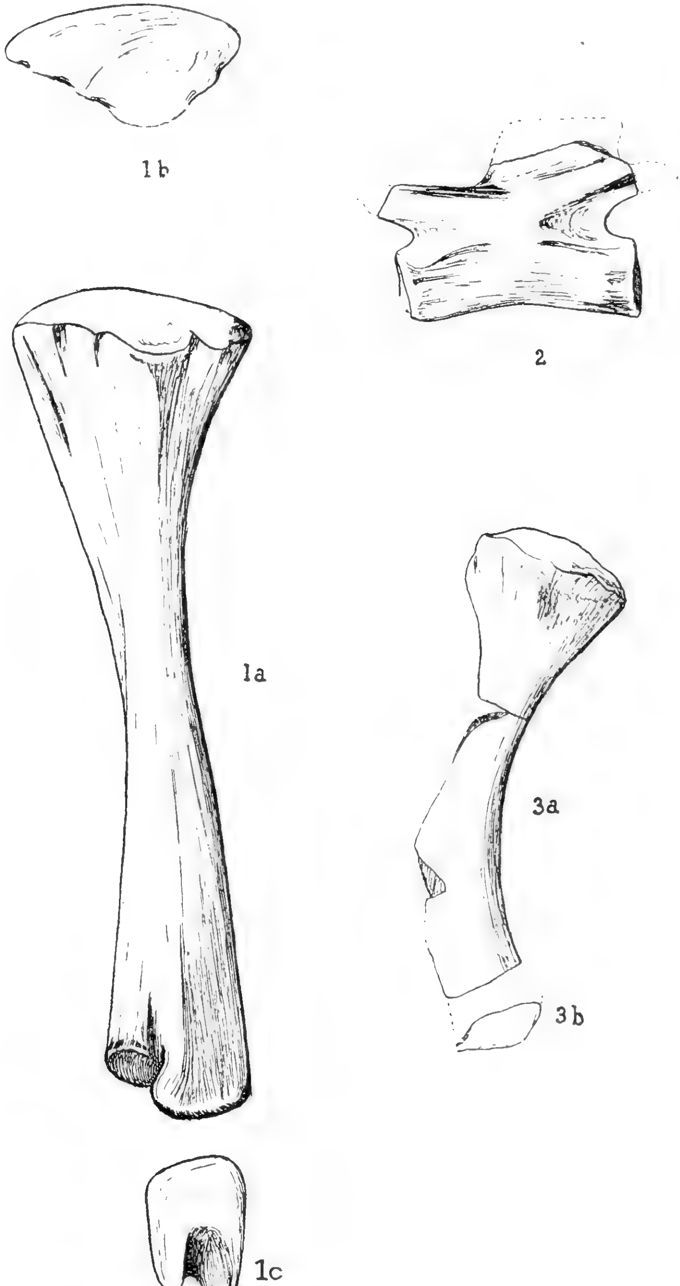


Fig. 21. *Thecodontosaurus minor*, Htn.

1*a*. Left tibia. 1*b*. Left proximal end. 1*c*. Left distal end.
2. Cervical vertebra. 3. Ischium. All natural size.

projection — the maximum width of the surface being 9 mm.

The nature of the tibia and the ischium mark these remains off from the *Plateosauridae* and place them among the *Thecodontosauridae.* They indicate a member of this family smaller than any hitherto described from South Africa and which cannot be exactly identified with any European species. I propose therefore to give it a new specific name ***Thecodontosaurus minor.***

Type. S. A. M. Cat. No. 3451.

Locality. Pitsing, Maclear, C. P. Cutting in road to Naude's Nek.

Horizon. Red Beds."

There is in the Bloemfontein Museum a slab of Cave Sandstone from Ladybrand, O. F. S., which I was kindly permitted to examine. The slab contains the cast of a right femur, tibia, the distal end of the fibula, metatarsals I–IV, and the first three digits of the pes of a Dinosaur; also part of the right ischium and two fragments of jaw with teeth. The form seems to correspond pretty closely with the type of ***Thecodontosaurus minor***, and I refer it to that species. It differs from ***Gyposaurus*** in being smaller and in having the metatarsals proportionately shorter.

One fragment of jaw is 50 mm. long and 9 mm. deep at the mentum. 14 mm. from the front it carries a single tooth 6·5 mm. long and 1·5 mm. in diameter. At the back of the fragment there are five teeth closely set together, the five occupying a space of 12 mm. and gradually decreasing in size from the first backwards. The largest is 6 mm. long. The teeth are widest some distance above the jaw and are serrated, at least on their posterior borders, in their upper halves. 3 mm. in advance of the largest is a slightly more slender tooth.

The other jaw fragment is 25 mm. long and carries 6 teeth in a distance of 18 mm. The longest tooth is 7 mm. long. All the teeth are serrated coarsely on their posterior and anterior borders.

The femur as preserved is a slightly curved shaft with very slightly expanded ends. The ends are, however, incomplete. The greatest length in a straight line is 135 mm., and along the front curve is 154 mm. The proximal width is 32 mm., the distal width 30 mm., and the width at the narrowest part of the shaft is 23·5 mm. The tibia is 117 mm. long, has a proximal width of 33 mm., and a distal width of about 23 mm. The following give the measurements of the metatarsus and pes.

	Length	prox. width	distal width
Metatarsal I	40		
1st phalanx	28	14	10
claw	36	15	
Metatarsal II	56	17	14
1st phalanx	26	13	
2nd phalanx	19	14	13
claw	29	12	
Metatarsal III	64	?	16
1st phalanx	26	18	?
2nd phalanx	21	14	12
3rd phalanx	16	11	11
claw	21	10	

The ischium as preserved has a greatest length of 100 mm. Near its junction with the pubis and ilium it has a width of 45 mm,, while at its narrowest part the width was probably not more than 15 mm.

Thecodontosaurus dubius sp. nov.

Two slabs of Cave Sandstone from Ladybrand, O.F.S., presented to the South African Museum by Mr. van Niekerk contain the larger part of the skeleton of a *Thecodontosaurus* which seems to be specifically distinct from any yet described from South Africa. A slab and counter slab from the Cave Sandstone of Rosendal, O.F.S., now in the Bloemfontein Museum, which I was kindly permitted to examine, contain remains of a somewhat smaller animal apparently of the same species.

As usual with the Cave Sandstone fossils the bones are badly preserved, and it has only been possible to expose one side of the type specimen. On the larger slab the dorsal and sacral vertebrae, pelvis, and the hind limbs are seen in ventral aspect, while in the smaller slab the caudal vertebrae are seen in lateral aspect mostly as moulds. In the Bloemfontein specimen besides an imperfect pelvis and hind limb there is preserved a very fine series of 54 caudal vertebrae.

In the type specimen 13 dorsal vertebrae are seen on the ventral surface — all crushed and weathered. The length of the posterior vertebrae is 44 mm. each, and the breadth across the articular surface is about 24 mm. Three sacral vertebrae are displayed. The length of each of the first two is 45 mm., and the maximum breadth

of the centra 30 mm. They are stouter than, and not compressed medially so much as, the dorsal vertebrae.

There are 20 caudal vertebrae preserved, having a total length of 710 mm., but the anterior caudals are not present. The anterior centra of those preserved are almost as high as long, having a length of 33 mm. and a height of 30 mm.; posteriorly the centra become lower so that the 13th has a height of 13 mm. to a length of 30 mm. Similarly the dorsal spines and the haemapophyses become shorter posteriorly. The 2nd haemapophysis preserved is 90 mm. long, the 15th 42 mm.

Both ilia are preserved, but incompletely. The anterior spine is missing, but the posterior spine of the left bone is long. The height of the upper border above the end of the postacetabular process is about 80 mm. The posterior spine was probably squarely truncate.

Both pubes are present, lacking their distal ends. The shaft was 38 mm. broad and thin. The proximal end is broadened and the pubic foramen is large and rounded. Both ischia are present in contact with each other and with the pubes; but they lack the distal ends. The proximal mesial parts of the bones are very thin. The ischium passes very strongly backwards.

Both hind legs are preserved in a flexed condition, but the feet are not in good condition.

The femora are only seen from the anterior side. The bone is slightly S-shaped, bent more proximally than distally. The right bone is 270 mm. long, the left 280 mm. The shaft of the larger bone is 35 mm. wide at its narrowest. The distal end of the right femur is 55 mm. broad. The 4th trochanter is not visible on either bone.

The right tibia is almost entire. It is 260 mm. long as preserved, but lacks the distal end. The proximal end is 70 mm. broad, with a somewhat sharp inner anterior end. The anterior face of the bone is flattened just above the middle, but becomes rounded distally. The shaft is 27 mm. broad at its narrowest and 25 mm. thick.

The left fibula is 250 mm. long, slightly bent, and slender. The ends are only slightly expanded.

Of the metatarsals 4 are preserved on the left side, probably I–IV. They are seen on their under surfaces. Their lengths, taken in order, are 71, 102, 110 and 95 mms.

This form is thus seen to be slightly larger than ***Thecodontosaurus browni***.

Type. S. Af. Mus. Cat. No. 3712.

Locality. Ladybrand, O.F.S.

Horizon. Cave Sandstone.

Gyposaurus capensis Broom.

1906. Broom. *Hortalotarsus skirtopodus.* Trans. S. Afric. Phil. Soc. XVI, 3, p. 201, Pl. III.

1911. Broom. Ann. S. Afric. Mus. VII, 4. p. 293.

The type consists of a partial skeleton in a block of sandstone, in which the following portions are displayed: Eleven dorsal and six caudal vertebrae, a few ribs and some abdominal ribs, part of the right scapula, both ilia, the right pubis and ischium, the right femur and fibula, tarsus and pes. The bones are only partly preserved, and the ends are imperfectly ossified.

In his 1911 paper Broom placed the form in a new genus on the following grounds. "Among the chief characteristics of this new genus the most noteworthy is the remarkable shape of the ilium. The iliac crest has a greater anterior extension than in any other known carnivorous Dinosaur, and the preacetabular process is relatively small. The femur is relatively stout, and has the *trochanter quartus* small and high up, and the *trochanter major* almost rudimentary".

The animal is of the same size as *Thecodontosaurus skirtopodus.* The ungual phalanges of the foot seem to be shorter than in that species, but the general proportions of the remainder of the foot are very similar.

Type. Partial skeleton in sandstone. S. A. Mus. Cat. No. 990.
Locality. Ladybrand, O. F. S.
Horizon. Cave Sandstone.

Aristosaurus erectus van Hoepen.

1920. van Hoepen. Ann. Transvaal Mus. VII, 2. p. 77. Plates IX–X.

The form is a small one, the type consisting of the larger portion of an animal exhibited on a slab and counter-slab of sandstone.

A portion of the left maxillary and left dentary is preserved. The crowns of the teeth are broad, flat, and have the edges serrated. The number of dorsal vertebrae is probably 14, and possibly 15. There are certainly two sacral vertebrae, and possibly a third. Van Hoepen says of the type "As appears from many loose sutural connections, our animal is a young individual, and has not yet reached the stage of life in which it possesses a true third sacral vertebra." The shoulder girdle is described as consisting of two scapulae and two coracoids. The coracoid has a supracoracoid foramen, which is fairly large and close to the middle of the scapular

border. The proximal end of the humerus is very broad, its upper border convex. Below the processus lateralis the lateral border is strongly concave. The shaft of the bone is narrow. The ulna is just over two-thirds the length of the humerus.

The spina posterior of the ilium is broad and truncated, the spina anterior short. The acetabulum is well in the anterior half of the bone. The pubis has a regularly concave lateral border and a straight medial border. The pubic plate is narrowest near its distal end, but it is slightly broader at the extreme end. The appearance of the pelvis has suggested to van Hoepen that there was a complete longitudinal symphysis between the pubes and ischia of the two sides of the animal.

The femur is pronouncedly sigmoidal in lateral view; the fourth trochanter is in the upper half of the bone. The tibia has a very large proximal end, and the tuberositas tibiae did not project very far. There is no thickening at the distal end of the bone. The hind feet are entire in the type. The fourth metatarsal is slightly longer than metatarsal II. Metatarsal III is more slender than the latter.

Discussing the affinities of the type van Hoepen says: „The nearest relations of our form are amongst the *Plateosauridae* and *Anchisauridae*. and it is clear that it belongs to either one or the other. The *Plateosauridae* are all medium sized to large Dinosaurs with fifteen dorsal vertebrae, whereas our form is small and has most probably fourteen dorsal vertebrae, agreeing in this respect with the *Anchisauridae*. There is further agreement with the *Anchisauridae* in the relation of the lower arm to the humerus; radius and ulna are longer than half the humerus. The length of the shaft of the humerus. stands to the length of the whole humerus as 58 : 93 or 0·62. This relation brings our form in close proximity of *Thecodontosaurus antiquus*. Taking all these facts into consideration it seems clear that our form is an *Anchisaurid*.

Comparison with *Anchisaurus* shows that the dorsal vertebrae are comparatively longer, and that the pubes of the two forms differ greatly. *Massospondylus* is a much larger form. The distal ends of its ischia are coalesced, and each is more or less triangular in section. In our form the distal ends of the ischia are flattened through pressure, but it is difficult to accept that their section was originally triangular. Moreover, they are not coalesced. The relations of the ileum of *Massospondylus carinatus* are different from those in our form, for it is longer than the latter with regard to its shortest height above the acetabulum. Relatively the dorsal vertebrae of our

form are longer than those of *Massospondylus carinatus.* The relations of the lengths of the metatarsals in *Massospondylus harriesi* is different from that in our form. In *Massospondylus harriesi* metatarsal II is longer than metatarsal IV, whereas in our form metatarsal II is shorter than metatarsal IV.

In comparing with ***Ammosaurus*** and ***Gyposaurus*** I need only refer to the great difference in the ilea.

The only other genus of the family is ***Thecodontosaurus.*** Superficially there is great resemblance between our form and the known species of ***Thecodontosaurus.*** A closer study, however, reveals remarkable differences.

A comparison of the ileum of our form with that of ***Thecodontosaurus antiquus*** shows that in the latter the spina posterior is much more produced. The acetabulum cuts deeper into the ileum of our form, which resembles the *Plateosauridae* in this respect. The highest point of the acetabular concavity is situated much nearer towards the middle of the bone than in our form, and this is another point of resemblance with the *Plateosauridae.* The ilium of our form is manifestly different from that of *Thecodontosaurus cylindrodon*, and also in the direction of the *Plateosauridae.*

The pubis of our form differs considerably from that of ***Thecodontosaurus antiquus***, as far as the latter is known. In our form the lateral edge of the pubis is regularly concave, whereas in ***Thecodontosaurus antiquus*** its upper end is sigmoidal. There is also great difference in the shape of the pubic foramina. The shape of the proximal end of the ischium of *Thecodontosaurus antiquus*, as far as preserved, is quite different from that of our form, a difference which is best understood from a comparison of the figures.

Another difference becomes conspicuous when the length of the humerus is expressed in lengths of dorsal vertebrae. Taking one of the hinder vertebrae v. Huene came to the following results: In ***Thecodontosaurus antiquus*** the humerus is about five times as long as the vertebra, and in *Thecodontosaurus skirtopodus* about four and a half times. In our form the length of the eleventh dorsal vertebra is 29 mm. The length of the right humerus is 93 mm.. which means that the humerus is only 3·2 times as long as the vertebra. Therefore, the humerus of our form is relatively much shorter than that of ***Thecodontosaurus antiquus*** and of ***T. skirtopodus.***

There is great difference between the ischium of ***Thecodontosaurus minor*** and that of our form.

The points of difference enumerated above show sufficiently that our form does not belong to any of the known genera of the *Anchi-*

sauridae. It, therefore, represents a new genus, for which I propose the name *Aristosaurus* n. g. with the species ***Aristosaurus erectus*** n. sp. ***Aristosaurus erectus*** is much more highly specialised than ***Thecodontosaurus***, *Ammosaurus*, ***Anchisaurus*** and even than ***Massospondylus***. The build of the pelvis, and especially the position of the ischium, shows adaptation to a usually bipedal mode of locomotion. The same may be concluded from the far forward position of the acetabular concavity in the ileum. The position of the trochanter quartus seems to be very low down on the femur. Its upper end is 41 mm. from the proximal end of the bone. The length of the trochanter is at least 18 mm. Therefore the lower end of the trochanter is situated at more than 59 mm. from the proximal end of the bone, which means very near to the middle of the femur. However, conclusions may not be drawn from this fact, because exact measurements cannot be obtained.

The humerus is much shorter in relation to the body than in the other ***Anchisauridae***. The anterior extremity is also relatively much shorter in relation to the posterior one than in all other ***Anchisauridae*** excepting ***Anchisaurus solus***. As in the ***Plateosauridae*** the tibia of ***Aristosaurus*** is much longer than the humerus. This is also the case in ***Anchisaurus solus***. In the other ***Anchisauridae*** it is the reverse. All this tends to show that ***Aristosaurus*** is an ***Anchisaurid***, highly specialised in the direction of the ***Plateosauridae***, and of the bipedal mode of locomotion."

Type. In the Transvaal Museum.

Locality. Rosendal, Senekal Dist., Orange Free State.

Horizon. Bottom of Cave Sandstone.

Although not specifically identifiable, the two bones in the collection of the Rhodesian Museum, Bulawayo, which were sent me for inspection by the Director of the S. Rhodesia Geological Survey, should be mentioned here as they are of interest in being the only known fossils from the Forest Sandstone of that region.

One bone, from Dingaan farm, Bubi District, is the distal end of a left fibula, measuring 120 mm. in length as preserved. The dimensions of the distal articular surface approximate to those of *Thecodontosaurus skirtopodus* (Seeley), but the bone differs from any of the described fibulae of this family or of the Massospondylidae or Plateosauridae in having a shaft subcircular in section, whereas those of the described species are more oval in section.

The other is a complete dorsal centrum from Waterfall farm, Bubi district. It differs from that of *Gyposaurus africanus* (Broom)

in that it is as high as broad. The length is 43 mm. and the lower border is moderately concave. The dimensions make it possible that it belongs to the same species as the other specimen. The articular surfaces for the arch are beautifully displayed. There is a fragment of an arch showing a transverse process with a very concave under surface and incomplete neck and caudal vertebrae together with fragments of ribs.

Fam. MASSOSPONDYLIDAE von Huene.

1914. von Huene. Fossilium Catalogus I, 4, p. 13.

Massospondylus carinatus Owen.

1854. Owen. Cat. Foss. Rept. Mus. R. Coll. Surgeons, p. 97.
1890. Lydekker. Cat. Foss. Rept. Amphib. Brit. Mus. IV, p. 246.
1895. Seeley. Ann. Mag. Nat. Hist. (6) vol. 15, p. 102.
1906. von Huene. Geol. u. Pal. Abh. N.F. Bd. VIII, hft. 2, p. 36, Pls. XIII–XVI.
1911. Broom. Ann. S. Afric. Mus. VII, 4, p. 291.

The following details of the type specimen are taken from von Huene's account, checked by examination of casts of the type which are in the South African Museum.

The cervical vertebrae are elongate, with a keeled under surface as in *Plateosaurus*. The zygapophyses are long anteriorly, and posteriorly are elongate with oblique articular surfaces. The neural spine is short, low, and thin.

The centrum of the 1st dorsal vertebra is characterised by the extraordinarily high thin keel on the ventral surface. A few of the other dorsal vertebrae are known. They are compressed in the middle and the ventral side is rounded.

The anterior caudals are very short and high, and broadly rounded below. The later ones are provided with a keel below and carry posteriorly a ventral groove, which divides partially the face for the articulation of the haemapophysis. The middle and hinder caudals are longer, but do not reach the length of the cervicals.

The scapula is small and slender and is characterised by a high alar process at the distal end on the upper side; the coracoidal half of this process is thin and concave from without, as in *Plateosaurus*, but more strongly so; the medial side of the process is flat. The distal end is broadened.

In the humerus the proximal end is broad, the upper border obliquely bent down to the processus lateralis which is sharply cut

off from the ridge, but is not bent so strongly forwards as in many other Triassic Theropoda. The caput humeri lies on the medial angle and is posteriorly thickened; the highest part of the upper border is similarly thickened. The distal end is broad and has its condyles directed strongly forwards.

The first metacarpal is an extraordinarily compact broad short bone. The proximal surface is triangular.

The ilium has a sharp but short anterior process; the spina posterior is long and moderately broad. The upper surface is bent inwards in the middle. The ridge above the acetabulum is not so roof-like as in many other genera. The crista interior on the inner side of the posterior process is not very prominent.

The middle and the distal end of the pubis is broadened and thin, the lateral and distal edges being thickened.

The femur is slender and lightly bent from front to back. The tibia has its distal end compressed from front to back, while the proximal end is convex medially and has a large tuberosity laterally. The anterior process is somewhat bluntly rounded. On each side of the tuberosity the lateral edge is hollowed out.

Von Huene separates the genus from *Plateosaurus* on account of its *Thecodontosaurus*-like tibia. The scapula, ilium, pubis, femur and hand are more strongly built than in *Thecodontosaurus.*

Type. Isolated bones in British Museum.

Locality. Beaucherf, Harrismith, O.F.S.

Horizon. Red Beds.

MASSOSPONDYLUS HARRIESI Broom.

Text figs. 21–29.

1911. Broom. Ann. S. Afric. Mus. VII, 4. p. 299. Plates XV–XVII.
1920. van Hoepen. *Massopondylus browni.* Ann. Transv. Mus. VII, 2. p. 118. Plates XVII–XXIII.

In his original description Broom says "This Dinosaur resembles *Massospondylus carinatus* sufficiently closely to suggest the advisability of placing it at least provisionally in the same genus. The remains consist of an imperfect humerus, a nearly perfect radius and ulna, and a perfect manus, as well as portions of the femur and tibia, and a number of toe bones all of one individual, and the perfect pes of another individual."

Re-examination shows that the remains supposed to constitute the first individual really contain two individuals. The supposed femur is in reality the distal half of a humerus, larger than that belonging

to the complete fore-arm; and doubt is thus thrown upon the identity of the tibia and bones of the hind foot with the forearm, although all are marked with Mr. Walker's collecting number "I". Certainly the supposed femur is no part of the type animal, and must be considered separately.

The pes described by Broom is admittedly part of another individual; but comparison of it with a few portions of a pes marked "I" and found with the fore-limb renders it probable that it belongs to the same species as the latter. I consider, however, the fore-limb as the type of the species.

Comparison with *M. carinatus* is confined to examination of the distal end of the humerus, the 1st. metacarpal, and the proximal end of the tibia. Broom has figured the 1st. metacarpal, displaying its general similarity with that of *M. carinatus*, the inner distal condyle of each being small compared with forms such as *Gryponyx.* The distal end of the humerus is somewhat distorted, but the condyles seem to bear a similar relation to one another to those of *M. carinatus.*

The tibia approximates more closely in size to that of *M. carinatus* than does the fore-limb, and probably belongs to a larger individual, possibly the same as that from which the larger humerus (described as femur) belongs. The proximal end of the tibia is slightly longer and considerably thicker in *M. carinatus*; the greater thickness being mainly due to the more prominent development of the tuberosity on the lateral face. The anterior process is similar in each. The posterior border of the bone is more concave proximally in *M. carinatus* than in *M. harriesi.*

The larger humerus consists of the distal portion from the condyles to the lower end of the deltoid crest. In shape and general proportions it corresponds closely with the humerus of the type fore-limb, the distal end being crushed in the same direction as the type. The width of the distal end as preserved is 114 mm. There is a broad shallow groove between the condyles on the posterior face, and a deeper excavation on the anterior face of the bone. Its size corresponds roughly to that of the humerus of *M. carinatus.*

The right pes has been fully described and figured by Broom. In size it stands much closer to the fragmentary remains of *M. carinatus* than does the fore-limb, and is thus of a larger individual which shows few features distinguishing it from *M. carinatus.*

Whilst collecting in the Herschel Division of the Cape Province I was fortunate enough to obtain from the hill overlooking the Blikana Trading Store (and thus from an horizon in the upper third of the Red Beds) an almost complete specimen of an animal which

can most easily be referred to this species. The caudal region had weathered off and was not obtained; but the remainder of the skeleton was found lying articulated with the exception of the head, which was at a distance of about 3 feet from the front of the neck. The specimen is one of the most complete known from the Stormberg Beds and has thus been thought worthy of a fairly full description, as it throws light upon the real position of these medium-sized forms. The specimen is in the collection of the South African Museum — Catalogue no. 5135.

Skull. The skull was lying detached from the neck at a distance of some 3 feet from it and was, unfortunately, shattered by a blow from a pick before its presence was realised. It has been possible,

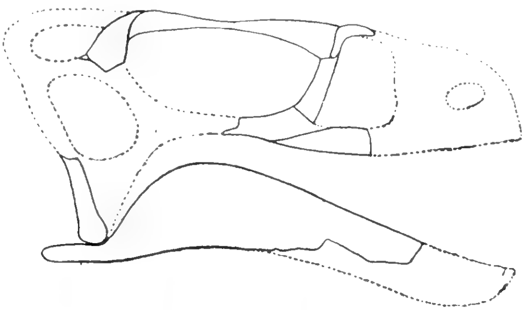


Fig. 22. *Massospondylus harriesi*, Br.
Restoration of a side view of skull (5135).
(The teeth are omitted from this restoration). × ½.

however, to reconstruct several portions of it from the fragments collected.

The basicranial region exhibits strong likenesses to that of *Thecodontosaurus antiquus* and is also fairly close to *Sphenosuchus acutus.* The occipital condyle is rounded and intermediate in size between that of *Sphenosuchus* and of *Thecodontosaurus.* It is formed almost wholly of the basioccipital, the suture between that bone and the exoccipital running as in *Sphenosuchus.* Anterior to the condyle the bone thins and then expands rapidly, its lower surface at the same time curving strongly downwards to form a long transverse basioccipital ridge. This ridge is not furnished with a median notch like that of *Sphenosuchus.* Its upper surface forms the floor of the brain-case for some considerable distance, the suture with the exoccipital being plainly seen on each side. The anterior portion of the bone is furnished with a median medullary ridge.

The suture between the basioccipital and basisphenoid is not traceable, but I am inclined to believe that it runs along the transverse ridge. If this be so, the structure is different from that of *Sphenosuchus*, where the suture runs along either side of the intertympanic foramina which lie wholly in the basioccipital, and agrees with that in *Plateosaurus* and *Thecodontosaurus*. The median excavation is smaller than in *Sphenosuchus*. The distance between the hinder end of the basisphenoid and the pterygoid apophyses of the bone is comparatively greater than in *Thecodontosaurus*. These apophyses are as in the European genus. Seen from above the anterior portions of the two apophyses meet superiorly to form a crest in advance of the circular hole for the hypophysis cerebri (pituitary fossa). The basisphenoid is furnished laterally just behind the root of the pterygoid apophysis with a deep groove corresponding in position to the recessus basisphenoidei of *Thecodontosaurus* figured by von Huene. The bottom of this pit is presumably pierced by the carotid foramen opening into the pituitary pit. Superiorly the relation of the basisphenoid with the bones of the side-wall of the brain case are obscure.

The foramen ovalis is only presented in section on the left side. It occupies the same position as in *Thecodontosaurus*, perforating the side-wall of the brain behind the sella turcica.

The exoccipital is of the form seen in *Thecodontosaurus*. Its lower border is grooved proximally, the groove running inwards and forwards to the foramen lacerum for the exit of nerves IX–XI. This opens into the bottom of the side-wall of the brain-case. Separated from this foramen by a thin plate of bone is a larger opening, the foramen jugulare for the passage of the VIIIth nerve. Mesial to the internal opening of this foramen is a shallow pit in the brain case. The opening for the XIIth nerve is only seen in vertical section passing through the exoccipital above the level of the condyle. Behind and above the foramen lacerum the side wall of the brain is furnished with two small foramina, presumably venous.

The exoccipital articulates with the basioccipital below and the supraoccipital above. It has a strong paroccipital process.

Save in details of relative sizes, this basicranium is similar to that of *Thecodontosaurus*, and differs in certain features more from *Sphenosuchus*.

A portion of the right side of the skull and lower jaw is preserved, attached to a part of the top of the skull. The snout is missing.

The orbit was large, its length as preserved being 54 mm. Its anterior border is formed by the pillar-like lachrymal which divides

the orbit from the antorbital vacuity. The limits of the prefrontal are doubtful, but it seems to be a small bone wedged between the lachrymal and frontal and extending forwards over the antorbital vacuity.

The frontal is a large bone meeting its neighbour in the middle line to form with it the whole of the interorbital space. It forms the whole of the upper border of the orbit and extends back to form part of the border of the anterior temporal vacuity. The postfrontal, if present, as a separate bone, is small and forms no part in the formation of the orbit although it may be part of the anterior border of the upper temporal vacuity. There is some doubt as to its separate identity and I am inclined to consider it as fused with the frontal as in *Sphenosuchus.*

The jugal forms the lower border of the orbit and meets the lachrymal and maxilla anteriorly. The maxilla, as preserved, carries 4 or 5 flattened teeth. The teeth are seen better, however, in the lower jaw.

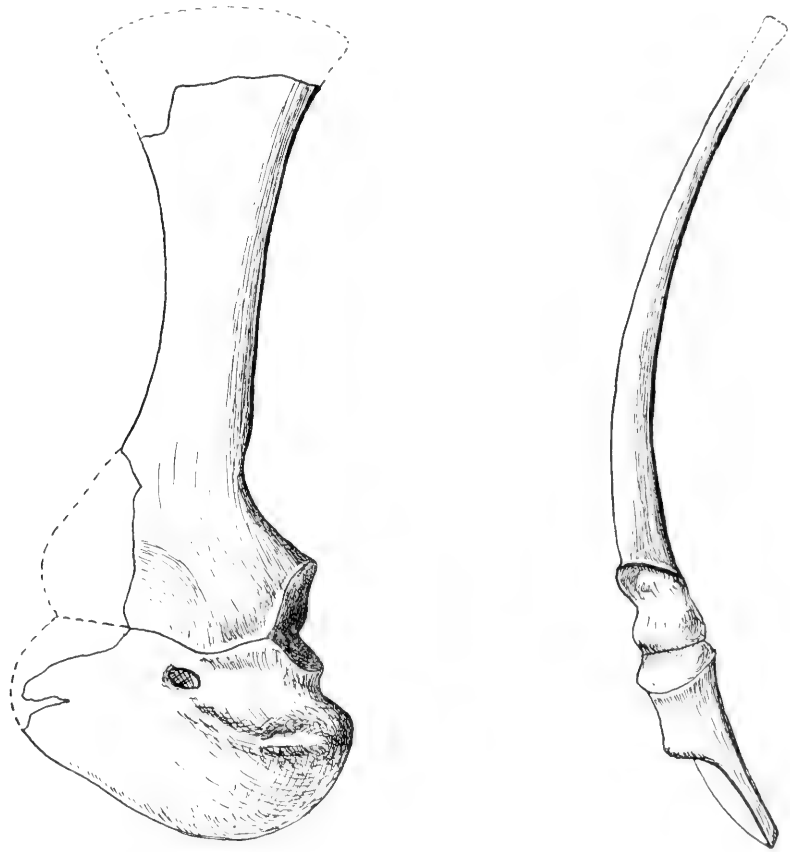
A length of 110 mm. of the lower jaw is present, the front missing. From the post-articular process the upper border rises in a regular high curve, concave at first and then convex, to a point below the middle of the orbit, whence it passes downwards and forwards. The lower border is almost straight. The teeth carried by the dentary are variable in size, large and small teeth apparently alternating. The teeth are flattened with the upper halves of the anterior and posterior borders serrated, as in *Thecodontosaurus.* The largest tooth seen is 7 mm. long and 3·5 mm. broad. There are 7 serrations in a distance of 4 mm. The cross-section of the tooth is an elongate oval.

Vertebrae. The cervical vertebrae are somewhat crushed and incomplete. The later cervicals agree closely with those of *Massospondylus carinatus.* The middle cervicals are very elongate, compressed in the middle, with a median ventral keel in the anterior half. The zygapophyses are long with very oblique articular surfaces. The neural spine is thin, low and long. The transverse process is in the form of a long ridge at the level of the top of the centrum. The whole body of the bone is slightly curved. The most complete bone gives the following measurements:

Length of centrum	105 mm.
Height of centrum . . , .	40 mm.
Greatest length	133 mm.
Max. height (probable) . . .	85 mm.

What is probably the last cervical has a centrum 73 mm. long

and 44 mm. high. The centrum is strongly compressed laterally and has a very sharp median ventral keel. The side of the centrum is furnished with a prominent parapophysis placed just behind the middle of the bone for the articulation with the rib. The anterior



A B

Fig. 23. *Massospondylus harriesi*, Br.
Left scapula and coracoid (5135).
A. External view. B. Ventral view.

cervicals have very shallow and elongate centra and comparatively massive processes. They are, with the exception of what is probably the first, very elongate; but the preservation is not sufficiently good to admit of full description. The anterior cervicals are very bird-like in general appearance.

Shoulder Girdle. Both scapulae are preserved, but are somewhat incomplete at the distal end and each lacks the end of the supra-coracoidal wing. The proximal end is very similar to that of the smaller scapula assigned by von Huene to ***Massospondylus carinatus.*** The glenoid cavity is the same size, the posterior half of the articular surface for the coracoid slightly larger and the shaft of the bone a little broader. The distal end expands fairly considerably, but not so much as in *Sphenosuchus acutus.*

The chief measurements are:

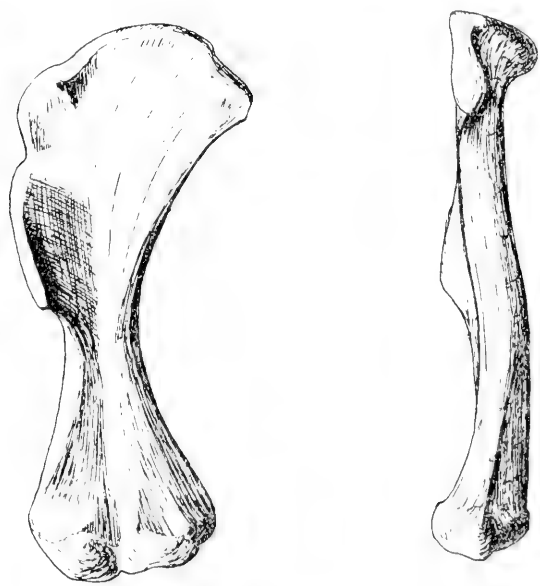
Probable greatest length . . .		280 mm.
Greatest width		104 mm.
Minimum width of shaft . . .		40 mm.
Greatest thickness at articulation with coracoid . . .	30 mm. (left)	43 mm. (right)

The left coracoid is almost entire, the right one represented by the posterior half. The inner surface is concave, the outer slightly convex except for a strong thickening in the middle of the lower portion of the bone. This thickening takes the form of a strong short longitudinal swelling which rapidly subsides into the bone at its upper and lower ends. This thickening is for the reception of the coraco-brachialis muscle, according to von Huene. In front of the coracoidal portion of the glenoid cavity the border is concave to the anterior ventral angle. The anterior border is regularly curved. The left coracoid is 135 mm. broad, 80 mm. high, and has a maximum thickness at the scapular surface of 30 mm.

Attached to the upper portion of the anterior border of the left coracoid is a small piece of bone lying generally in a plane at right angles to that of the coracoid and bent in a convex manner when viewed from in front. In collecting the shoulder girdle a number of pieces of thin bone were found in situ in the region of the two coracoids. These have been fitted together as much as possible and seem to give indisputable evidence of the presence of two clavicles and an interclavicle. These bones are too fragmentary to permit of full description. The largest fragment is a piece which I take to be the interclavicle. As preserved it is 86 mm. long. The bone is a thin plate broadening somewhat posteriorly, and possibly anteriorly, slightly convex from side to side ventrally save in the anterior portion where there is a prominent longitudinal swelling for the attachment of muscles, similar in form to that on the coracoids. The dorsal surface is flat, so that the edges of the bone are thin. Lying at the

anterior end of the dorsal surface is a fragment of a clavicle, which here at its distal end is a thin plate of bone.

Humerus. The left humerus is slightly larger than the right and has the deltoid portion bent into the body of the bone slightly more than the other. Both humeri are complete and are of the general type seen in the Vienna specimen of *Thecodontosaurus skirtopodus*, although the bottom of the deltoid crest is just *below* the middle of the bone. The deltoid crest is sharply cut off from the lateral edge



A B

Fig. 24. *Massospondylus harriesi*, Br.
Right humerus (5145).
A. Anterior view. B. Medial view. × $\frac{1}{3}$.

of the proximal portion by an abrupt change in the outline of the bone; and the process is but slightly bent from the general plane of the upper half of the bone.

The outer edge of the proximal end is strongly thickened to form a rounded knob about 35 mm. from the medial angle.

The medial edge of the bone forms a regular sweeping concave curve from the caput humeri to the inner condyle. The distal end is strongly broadened, and on the inner face there is a shallow depression between the two condyles. Anteriorly there is a medial

ridge which bounds one side of a shallow hollow lying above the inner condyle. The outer condyle is slightly larger compared with the inner than in the type of the species.

The chief measurements are:

	Right humerus	Left humerus
Greatest length	219 mm.	223 mm.
Breadth at distal end . .	75 ,,	78 ,,
Width at narrowest part of shaft	29 ,,	29 ,,
Width at top of deltoid crest .	80 ,,	70 ,,
Greatest width of proximal end	94 ,,	87 ,,
From lower end of deltoid crest to furthest part of distal end	108 ,,	110 ,,
Length of deltoid crest . .	55 ,,	55 ,,
Thickness of head . . .	16 ,,	17 ,,
Max. thickness of proximal end	27 ,,	29 ,,
Thickness at inner condyle .	25 ,,	24 ,,
Thickness at outer condyle .	24 ,,	26 ,,

Radius. Both radii are preserved, the left bone being crushed proximally. The right is slightly shorter than the left, but each has the same general form. The right radius is 132 mm. long, the left 135 mm., each being considerably shorter than the ulna.

The proximal articular surface is saddle-shaped. Below it the bone rapidly thins, so that the whole bone is a straight cylindrical shaft with expanded ends. The anterior edge is provided with a rounded ridge. At the distal end the posterior-medial face has two knobs, presumably for muscle articulation, a larger medial one and a smaller posterior one. At the proximal end the medial groove for the insertion of the humero-radialis muscle is very prominent.

Breadth of proximal surface . .	36 mm.
Thickness of proximal surface . .	25 ,,
Breadth of distal end . . .	32 ,,
Thickness at distal end . . .	23 ,,
Minimum width of shaft . . .	16 ,,

Ulna. Both ulnae are preserved, but the left is somewhat imperfect. The right gives the following measurements:

Greatest length	152 mm.
Width at proximal end . . .	52 ,,
Width at distal end	40 ,,

Width at narrowest part of shaft .	17	mm.
Thickness of proximal end . .	31	,,
Thickness of distal end . . .	20	,,

The distal quarter of the bone is twisted to the left as in the type. The bone is more elongate than that of *Plateosaurus quenstedti* and the proximal end is more expanded. The proximal half is somewhat similar to that of *Plateosaurus erlenbergensis*, but the articular surface slopes more strongly and the lateral angle lies nearer the anterior point. The medial border of the proximal end is concave and below it the surface of the bone is hollowed out. The anterior border of the bone is concave, the posterior border straight except at the distal end, where it curves outwards and slightly backwards.

Fig. 25. *Massospondylus harriesi*, Br.
Right ulna (5135). × $\frac{1}{3}$.

Hand. On the right side there are preserved the three carpale, the 1st. metacarpal and the whole of the 1st. digit. Of the left hand there are the 1st. and 2nd. carpale, all the metacarpals, and the 1st. digit. In addition there is an isolated claw of the right hand.

The 1st. carpale articulates distally with the 1st. metacarpal and the 2nd. carpale. It is an irregularly oval-shaped thin bone, with a maximum length measured from the medial end to the lateral end of 39 mm. in the left hand and 36 mm. in the right. The thickness between the dorsal and ventral edges is 25 mm. (24 mm. on right side). Between the proximal and distal surfaces the distance is 13 mm. (12 mm. on right).

The 2nd carpale is a small bone, articulating proximally for most of its length with the 1st carpale, distally with the 2nd metacarpal, and medially with the 1st metacarpal. Its dorsal surface is small, its palmar face rectangular with an area of 23 mm. × 12 mm. (18 × 13 on right). The distance between the dorsal and palmar surfaces is 19 mm. (16 mm. right).

Fig. 26. *Massospondylus harriesi*, Br.
Left pubis (5135).
Ventral view. × $\frac{1}{3}$.

The 1st metacarpal has a maximum length of 42 mm., a proximal width of 38 mm., and a distal width of 35 mm. The proximal end is almost triangular in shape, the ulnar edge having a length of 25 mm. In shape it compares closely with that of *Massospondylus carinatus*, but the distal articular surface is thicker than in the larger form. Also the ulnar proximal edge of the dorsal surface is pointed and not flattened as in *M. carinatus*.

The 2nd metacarpal has only the proximal half remaining. Its

end is 20 mm. broad and 24 mm. thick. On the radial side it has dorsal and palmar knobs with a hollow between, and on the ulnar side there is also a groove for muscle insertion. The dorsal side is slightly hollowed, but the palmar side is flat. The shaft of the bone is slender and circular.

The 3rd metacarpal is 53 mm. long, 29 mm. broad proximally, and 21 mm. broad distally, and the thinnest part of the shaft has a breadth of 13 mm. For the 4th and 5th metacarpals the corresponding measurements are 42 mm., 20 mm., 16 mm. and 9 mm., and 28, 18, 13, and 11 mm. respectively.

In the 1st digit the 1st phalanx is 37 mm. long. Its proximal width is 31 mm., its distal width 23 mm. It is so twisted that the claw curves strongly inwards and but slightly downwards. The claw has a length as preserved of 65 mm., and when complete was probably 75 mm. long. It is strongly curved and compressed dorso-ventrally. The greatest breadth at the proximal end is 36 mm. and the thickness, which is greatest on the radial concave side of the claw, 24 mm. There is a large bony process on the radial side at the proximal end for the insertion of the flexor tendon.

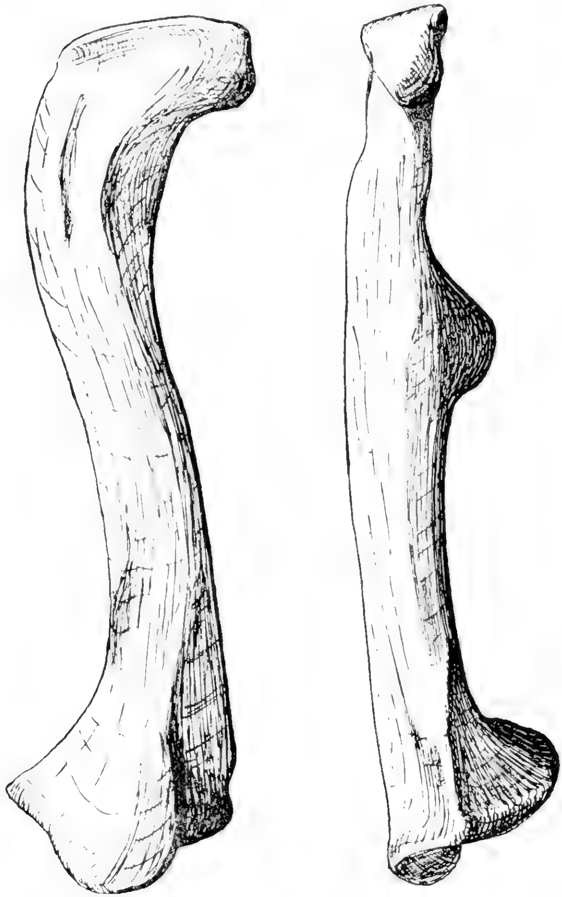
Pubis. Both pubes are preserved, entire save for the ischial articular surfaces. The head of the right pubis is somewhat distorted and the bone has a maximum length of 270 mm. The maximum length of the other bone is 285 mm. The breadth at the distal end is about 50 mm. and the thickness 23 mm.; but the breadth decreases to 43 mm. and the thickness to 12 mm. in the middle of the bone. The medial portion is very thin; the lateral border fairly sharply rounded. At a distance of 210 mm. from the distal end the public plate is turned abruptly downwards at right angles in its medial portion while the lateral part, now forming the pubic neck, is curved more gently upwards and outwards. The subacetabular process is 50 mm. long and 30 mm. broad. The pubic foramen is large.

The pubis is seen to be longer than was supposed by von Huene for ***Massospondylus carinatus.*** The distal end is somewhat thicker than in the Plateosauridae.

Femur. The femur fairly slender and slightly bent backwards at its distal end. The proximal end is bent strongly inwards, more so than in ***M. carinatus.*** The trochanter minor is not defined, but the trochanter major stands out as strong, somewhat curved, crest on the anterior face of the bone. The chief measurements are:

Greatest length	355 mm.
Width at head	75 ,,

Thickness at head	32	mm.
Distance from head to top of trochanter major	55	,,
Width at top of trochanter major .	51	,,



A B

Fig. 27. *Massospondylus harriesi*, Br.
Right femur (5135). $\times \frac{1}{3}$.
A. Anterior view. B. Medial view.

The 4th trochanter is a fairly short high thin crest on the posterior face, lying well within the upper half of the bone.

Distance from head to top of trochanter IV	88 mm.
Distance from head to bottom trochanter IV	142 „

The distal end of the bone is bent backwards and swells considerably to form the condyles. The lateral condyle is narrow and turns

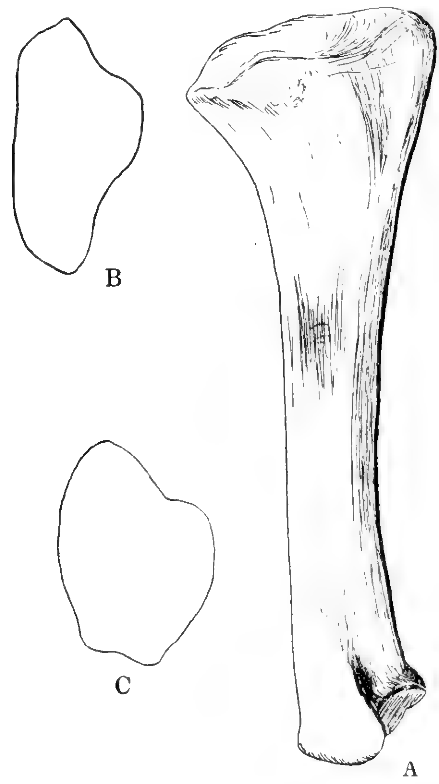


Fig. 28. *Massospondylus harriesi*, Br. (5135).
A. Right tibia lateral view.
B. „ „ outline of proximal end
C. Left tibia outline of proximal end $\times \frac{1}{3}$

outwards, and from it a sharply rounded ridge runs up the bone a distance of about 80 mm. The inner condyle is broader and less deep, and stands higher than the lateral condyle. Between the two is a narrow, deep groove, narrower than that of *M. carinatus*. The articular surface is inclined at an angle of about 70° to the anterior

slope of the bone. On the anterior face there is a short median depression above the condyles.

Maximum thickness at distal end .	79 mm.
Thickness of lateral condyle . .	20 ,,
Thickness of medial condyle . .	39 ,,
Depth of lateral condyle . . .	73 ,,
Depth of medial condyle . . .	63 ,,

Tibia. The right and left tibiae are complete. The proximal portion of the right has been flattened laterally, so that the head is considerably narrower than that of the left. The outline of the head of the bone differs in the two. The right tibia has a concavity both before and behind the lateral tuberosity as in ***Massospondylus carinatus***; the left tibia has the anterior concavity, but behind the tuberosity the edge is regularly convex to the posterior point. It can thus be seen that considerable care must be taken in distinguishing forms by such features as the shape of the tibial head, which is variable even in an individual.

The general shape of the proximal end approximates closely to that of *M. carinatus* and needs no detailed description. As a whole the bone is slender with the distal end but slightly expanded. The anterior condyle lies above the posterior and looks both outwards and downwards. The chief measurements are:

	Right	Left
Greatest length	300 mm.	298 mm.
Length of proximal end .	100 ,,	87 ,,
Width of proximal end .	50 ,,	61 ,,
Minimum width of shaft .	24 ,,	28 ,,
Minimum thickness of shaft	35 ,,	23 ,,
Length anterior border, distal end . . .	59 ,,	65 ,,
Length posterior border, distal end . . .	45 ,,	41 ,,
Max. thickness, distal end	42 ,,	37 ,,

Fibula. The right fibula and most of the left are preserved. The bone is slender, flattened laterally, slightly expanded at the end and almost straight. The inner face at the proximal end is hollowed out with a well-marked sharp crest bounding it anteriorly. In the mid-part of the bone the medial face has a slight longitudinal ridge anteriorly. At the distal end the anterior and posterior faces are

flattened and the lateral edge is broadly rounded. The lateral side has a strong longitudinal crest running for a short distance up from the condyle. In rear of it is a shallow groove, bounded posteriorly by another short prominent ridge. The distal articular surface is convex.

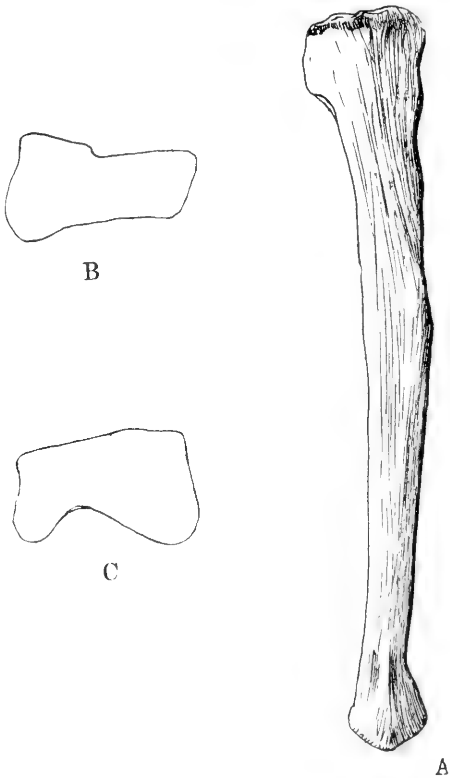


Fig. 29. *Massospondylus harriesi*, Br. (5135).
A. Right fibula, lateral view.
B. Right astragalus. Front view.
C. „ „ . Top view.
All $\times \frac{1}{3}$.

	Right	Left
Total length of bone . .	290 mm.	—
Length of proximal surface	48 „	46 mm.
Width of proximal surface	27 „	30 „
Minimum width of shaft .	15 „	15 „
Length of distal surface .	42 „	49 „
Width of distal surface .	29 „	21 „

Hind Foot. The right hind foot was found in situ, while most of the bones of the left foot were recovered from the talus below the site.

Astragalus. — The astragalus is preserved on both sides of the body. The maximum width from side to side is 72 mm. in the right bone and 76 mm. in the left. The maximum thickness in the medial half is 43 mm. (left, 40 mm.) and the maximum height in that half 31 mm. (left, 30 mm.). The lateral portion shows a high flattened upper portion for articulation with the anterior distal condyle of the tibia and posteriorly a low elongate narrow surface. Below the anterior articular face the bone is undercut posteriorly. The lower anterior angle is a short rounded prolongation, the posterior corner being broadly rounded. The lateral face shows a small shallow concavity for articulation with the calcaneum.

The thickness at the lateral end is 31 mm. (left, 27 mm.), the height 37 mm. (left, 37 mm.), and the breadth of the anterior upper surface 17 mm.

The under surface is broadly convex with a faint median ridge running from left to right.

Calcaneum. — A bone which I take to be the calcaneum is preserved in connection with the right foot. It is roughly triangular in outline, with a small lateral protuberance. Its upper surface is concave, its lower convex. Its greatest width is 36 mm. and its maximum thickness 21 mm.

Tarsalia. — The only other bone of the tarsus preserved is tarsale III, which is found in both feet in articulation with the third metatarsal. In section it is triangular, and its upper surface slopes from the back inwards and forwards so that it is thickest in its posterior and lateral parts. Its under surface is hollowed with a short medial anterior peg to fit closely to the proximal surface of the metatarsal. Its anterior edge is 28 mm. long, its medial face 31 mm., and its other face 41 mm. Its greatest thickness is 20 mm.

The following table gives the chief measurements of the metatarsals and phalanges of the right foot. The 3rd. digit is missing ; it was not preserved with the remainder of the animal, and was possibly lost during life.

	Length.	Prox. breadth.	Distal breadth.
Metatarsal I	86 mm.	33 mm.	30 mm.
Digit 1. 1st phalanx	51 ,,	29 ,,	23 ,,
claw	72 ,,	22 ,,	—
Metatarsal II	128 ,,	—	—
Digit 2. 1st phalanx	48 ,,	36 ,,	32 ,,

		Length.	Prox. breadth.	Distal breadth.
	2nd phalanx	36 mm.	29 mm.	25 mm.
	claw	61 "	24 "	—
Metatarsal III.		142 "	36 "	33 "
Metatarsal IV.		125 "	47 "	28 "
Digit 4.	1st phalanx	41 "	30 "	26 "
	2nd phalanx	36 "	29 "	25 "
	3rd phalanx	27 "	21 "	21 "
	4th phalanx	23 "	20 "	19 "
	claw	47 "	18 "	—
Metatarsal V.		67 "	37 "	—
Digit 5.	1st phalanx	17 "	— "	—

Comparison of these with the type pes of ***Massospondylus harriesi*** shows that the phalanges of the digits have almost indentical measurements in the two animals. The metatarsals in this animal have different lengths, however, those of ***M. harriesi*** being somewhat longer, except in metatarsal I.

The metatarsals show few distinguishing features. The proximal end of metatarsal II has the plantar edge considerably longer than the dorsal, while the medial and lateral faces are both hollowed out for articulation with the neighbouring bones. Metatarsal I looks almost entirely inwards. Metatarsal IV is a much flattened bone, and its distal end is slightly twisted inwards. Metatarsal V thins rapidly at its proximal end and from the lateral face, and lies almost entirely behind metatarsal IV. Its distal half shows the usual pads for the reception of tendons or muscles, especially on the plantar surface.

Among the collection of the Durban Museum submitted to me is an incomplete animal from Foutanie, Fouriesburg, O.F.S. (the type locality) consisting of a right scapula, a right humerus, a left coracoid, a left fibula and digits 1, 2, 3, of a left pes. These closely correspond with the type and must be placed within the species. The right scapula has the ventral edge a little straighter than in the Blikana specimen, being thus closer to the specimen described by van Hoepen as *Massospondylus browni*. The left fibula has a maximum length of about 285 mm. and a proximal surface 43 mm. long, and 20 mm. wide. The bone is flattened laterally, especially at the distal end. Its inner face at the proximal end is concave, its outer face convex. The proximal end is slightly more slender than in the Blikana specimen. The digits of the left pes correspond very closely to the type in size.

It seems to me that van Hoepen is probably in error in assigning

the remains described by him from St. Fort, Bethlehem, O.F.S. to *Massospondylus browni*. The only possible comparison that can be made is between the femora. and it is apparent that, not only is the proximal end of the type of *M. browni* (i.e. *Thecodontosaurus browni*) stouter than in van Hoepen's specimen but the trochanter quartus is nearer the proximal end. Moreover, the type is a considerably smaller animal, and has been assigned by von Huene, whose judgment cannot lightly be set aside, to the genus *Thecodontosaurus*. There can be no doubt that Dr. van Hoepen's species belongs to the genus *Massospondylus*, and the question arises whether it is a specimen of *M. harriesi* to which it closely approximates in size.

Comparison can first be made with the almost complete specimen of *M. harriesi* from Blikana. This shows that the humerus is almost exactly the same shape, and very slightly smaller; the ulna differs in that the Cape specimen has a slightly more slender shaft and has a posterior prolongation at the proximal end, which may have been worn off in van Hoepen's specimen; the radius of the former has a more slender shaft, swelling somewhat more abruptly at the ends; the scapula and coracoid are very similar, save that the distal end of the St. Fort specimen is apparently slightly narrower, thus coming closer to the type; the femur of the Blikana specimen is more strongly bent in anterior view and straighter in lateral view — but the St. Fort animal is considerably crushed; the tibia and fibula both show slight differences, and the bones of the feet are slightly more slender and longer in the St. Fort animal.

When compared with the type of *M. harriesi*, however, the differences in the foot are not so great; and in view of the fact that van Hoepen's specimen in closer to the type than is the South African Museum animal which I have referred to *M. harriesi*, I cannot refrain from including it in the same species. Four specimens of *M. harriesi* are thus known — the type, the South African Museum animal, the bones described by Dr. van Hoepen, and a partial skeleton in the Durban Museum. Of these, the first and last are from the one locality, the third from a closely-neighbouring area, and the other from some distance away and a slightly lower horizon. From them we can see the amount of individual variation that may occur within one species; and such variation should be taken into account when the identification of forms is under consideration.

Type. Bones of fore limbs — S. A. Mus. Cat. No. 3394.

Locality. Foutanie, Fouriesburg, O. F. S.

Horizon. Top of Red Beds.

MASSOSPONDYLUS SCHWARZI, sp. nov.

The bones upon which this species is founded were unearthed by Professor Schwarz at Makomoreng, Mount Fletcher, C. P. They are in the collection of the South African Museum (Cat. No. 5134).

The species differs from *M. harriesi* and *Aetonyx palustris* in the comparative size of the metatarsals. Taking the first metatarsal as a standard, the second and third are longer in this form than in the other species, in this respect the foot approximating most to *M. harriesi.* In addition, the phalanges of the digits are relatively longer than in the other forms, those of the third digit being actually as large as in *M. harriesi* which has a third metatarsal 20 mm. longer than in this new form.

These differences seem sufficient to justify the provisional erection of a new species for these remains; they certainly cannot be placed in any described species until we know more concerning the limits of individual variation among these Dinosaurs. The distal end of the tibia is somewhat more swollen than in *M. carinatus*, but as the foot bonse seem to approximate more closely to *Massospondylus* than to *Aetonyx*, I shall provisionally name the form *Massospondylus schwarzi.*

The following table gives the chief measurements of the bones of the foot:

	Greatest length.	Proximal width.	Distal width.
Metatarsal I	71 mm.	33 mm.	30 mm.
1st phalanx	41 ,,	27 ,,	23 ,,
claw	imperfect	19 ,,	—
Metatarsal II	118 mm.	prob 25 ,,	33 ,,
1st phalanx	47 ,,	31 ,,	27 ,,
2nd phalanx	31 ,,	21 ,,	13 ,,
claw	imperfect	15 ,,	—
Metatarsal III	135 mm.	22 ,,	31 ,,
1st phalanx	47 ,,	31 ,,	22 ,,
2nd phalanx	34 ,,	23 ,,	20 ,,
3rd phalanx	30 ,,	21 ,,	19 ,,
claw	imperfect	19 ,,	—

Associated with the foot are some portions of the leg and sacrum which are too imperfect for accurate determination.

Type. Incomplete pes and distal end of tibia. S.A. Mus. Cat. No. 5134.

Locality. Makomoreng, Mount Fletcher, C.P.

Horizon. Red Beds.

Aetonyx palustris Broom.

Text fig. 30.

1911. Broom. Ann. S. Afric. Mus. VII, 4. p. 304. Pls. XV and XVII.

The type consists of "a few imperfect dorsal vertebrae, a good scapula and coracoid, a good humerus, a good radius and imperfect ulna, the greater part of each manus, the upper end of one tibia, and the almost complete right pes".

A little extra description can be added to that given by Broom. There are portions of three cervical vertebrae attached to one another, of which the middle one is almost complete. The centrum has a length of 70 mm. and a height at the articular surface of about

Fig. 30. *Actonyx palustris*, Br.
Right Metatarsal. I. (Durban Mus.).
Distal end, front view.

35 mm. The maximum height of the bone is 68 mm. As in *Massospondylus* the centrum is elongate and compressed with a concave ventral surface; but the median ventral keel is not nearly so prominent as in the larger form. The neural spine is slightly higher than in *M. carinatus*, but is of the same type. The zygapophyses, as far as they can be seen, agree with those of *Massospondylus*. The transverse processes are small.

Several vertebrae from the posterior part of the tail are preserved, seven of them in association, and others now isolated but forming, according to Mr. Walker's field numbers, a series of 8. The former are more complete than the latter.

The length of the centrum in the first series diminishes from 25 mm. to 23 mm. with the last having a length of 20 mm. The maximum height of the largest bone is 22 mm., and of the centrum 11 mm.

All are slightly expanded at the ends, with the ventral surfaces rounded. They call for little comment, being of the type seen in *Sellosaurus fraasi*, figured by von Huene, with the exception that the zygapophyses stand somewhat higher from the centrum in *Aetonyx*. The dorsal spine is very small.

In the other series the centra only are preserved. They vary in length from 33 mm. to 26 mm., and are thus anterior to those already described. The ventral surface of the centrum is rounded but in its posterior half it is somewhat flattened with two short incipient keels flanking the flattened portion. These keels arise from the small oblique ventral face of the hinder end, which carried a small chevron.

Type. Partial skeleton, S. A. Mus. Cat. No. 2768, 2769, 2770.

Locality. Foutanie, Fouriesburg, O. F. S.

Horizon. Top of the Red Beds, Stormberg Series.

There are in the Durban Museum collection several bones which I ascribe to a large specimen of this species. They are from Foutanie, Fouriesburg, but it is uncertain whether all belong to the one animal although the probability lies in that direction. They consist of metatarsals I–III of the right side, metatarsal I of the left side, the distal end of a fibula and the distal end of a tibia the latter somewhat doubtfully assigned to this species.

The metatarsals of the right foot are approximately of equal length with those of the type *Massospondylus harriesi*; but they are more slender. The 1st metatarsal differs from that of *Massospondylus* in having a narrower proximal end, the medial upper edge being more convex, and in the slope of the distal end being much more oblique with the lateral portion of the articular surface very much swollen. The total length of the left metatarsal I is 82 mm.

The distal end of the fibula differs from that of *M. harriesi* in having a more flattened shaft and less prominent ridges at the distal end on the posterior face.

Dromicosaurus gracilis v. Hoepen.

1920. van Hoepen. Ann. Transv. Mus. VII, 2. p. 103. Pls. XIII—XVI.

This is a form slightly larger than *Massospondylus carinatus*, but closely allied to *Massospondylus* and *Aetonyx*. The type consists of fragments of humerus and radius, a fairly complete cervical vertebra,

some caudal vertebrae, the pubes, the ischia, a femur, a tibia, a fibula and some foot-bones.

Van Hoepen has pointed out certain differences between this and previously described forms. The outstanding features seem to be judging from the description and figures given, the straightness of the femur and the great height of the anterior end of the proximal surface of the tibia. Further, the lateral edge of the pubis is much straighter than in *Massospondylus harriesi* or in *Gryponyx africanus*, the only known South African forms of similar size in which it is satisfactorily preserved.

In connection with the original description and comparison of this form with *Massospondylus harriesi* it should be noted that the tibia and "femur" described by Broom, upon which van Hoepen based his comparisons, are probably not bones of the type at all, as pointed out in my re-description of *M. harriesi* in the present paper. Nevertheless, the tibiae of the two forms do vary in shape, the head of that of *D. gracilis* being much more inclined to the axis of the shaft than that of *M. harriesi*.

Type. Partial skeleton in the Transvaal Museum.

Locality. Naauwpoort Nek, Bethlehem, Orange Free State.

Horizon. Red Beds.

Fam. PLATEOSAURIDAE von Huene.

Plateosaurus stormbergensis Broom.

1915. Broom. Bull. Amer. Mus. Nat. Hist. XXV p. 162, figs. 48, 49.

A species of a large size, founded on a right femur, a right first metacarpal, portions of vertebrae and portions of the pubes.

The first metacarpal is much longer than broad, 99 mm. long and 56 mm. wide distally. The bone is more elongate than in *Massospondylus* or *Gryponyx*.

The femur differs from that of *P. cullingworthi* in its thinner proximal end, its narrower distal end, and the slightly lower position of the trochanter quartus. The medial distal condyle also appears to be much stouter in *P. cullingworthi*. It differs from *Gryponyx* in that the trochanter quartus does not lie wholly in the upper half of the shaft; but it is not so low down as in *Euskelesaurus* or *Melanorosaurus*.

The pubis has a broad anterior plate.

Two phalangeal bones collected by Dr. D. R. Kannemeyer at Witkop, Jamestown, C.P. — the type locality — and now in the South African Museum (Cat. No. 1875) probably belong to this species. One has a length of 55 mm., a proximal width of 32 mm., a proximal height

of 28 mm. and a distal width of 30·5 mm. At the distal end the medial portion of the articular surface is bigger than the lateral. The other bone, which is probably the first phalanx of the first digit of the left foot, has an axis which curves outwards at the distal end. The greatest length is 53 mm., the proximal width 33 mm., and the maximum distal width 32 mm. At the distal end the palmar surface is much broader than the dorsal surface.

Type. In collection of American Museum, New York. (Cat. No. 5605.)

Locality. Witkop, near Jamestown, Aliwal North, C.P.

Horizon. Base of Red Beds.

Plateosaurus cullingworthi, sp. nov.

Text figs. 31—35.

At Kromme Spruit, Herschel, C. P. a number of fragments of large Dinosaurian bones belonging to 3 or 4 individuals were found weathered out down one of the slopes of a steep kopje formed of the basal rocks of the Red Beds. At one point near the top of the same kopje bones were found in situ. Excavation revealed a "pocket" of isolated bones belonging to two individuals — a larger and a smaller — of apparently the same species. Some of the weathered bones, including two femora, have also been associated with these remains; the remainder belong obviously to an animal of heavier build, having large and heavy dorsal vertebrae and have been described as a species of *Euskelesaurus.* The bones from the pocket, together with the two femora and one or two other bones are considered to belong to a new species of *Plateosaurus* which I have named in honour of Mr. C. W. Cullingworth to whose energy some of the finds are due.

Although this form shows some differences from the more typical members of the genus from Europe, especially in the greater length of the humerus compared with that of the other bones, it has not been considered advisable to separate it generically from ***Plateosaurns.***

Vertebrae. *Cervical.* Judging from the curvature of the ventral border of the centrum, the only cervical vertebra preserved (S. A. M. Cat. No. 3345) is probably the 3rd. or 4th. or possibly the 5th. Taking a line at right angles to the end faces, the posterior ventral point lies 34 mm. below the anterior ventral point. The total length of the centrum is 157 mm. Its ends are roughly circular, the anterior 57 mm. high, the posterior 61 mm. The posterior end is more deeply concave than the anterior, and both have their ventral

borders rounded off. From the anterior end there runs a strong ventral median keel which gradually dies away until it disappears in the posterior third of the centrum. The whole vertebra is compressed in the middle. The small diapophysis lies on the upper half of the centrum. 40 mm. from the anterior border. Below and anterior to it is a small horizontal parapophysis. Between the two is a fairly deep groove. The prezygapophyses extend well in front of the centrum and have slightly convex facets. Seen from in front they form between them a wide V-shaped groove for the reception of the preceding postzygapophyses. Their lower borders are horizontal, so that each process thickens rapidly laterally. The postzygapophyses are slightly shorter than the anterior processes. The facets are slightly concave. The whole process is strongly built. The neural spine is missing; but its base is long and narrow, and the spine must have been low.

Dorsal. An anterior dorsal centrum (Cat. No. 3345a) has a length of 102 mm.; its ends are 80 mm. high and 70 mm. wide. In the middle the body is strongly constricted, having a width of only 24 mm. The ventral border is concave and has a sharp longitudinal keel. The ends are concave, equally so, and their ventral borders are rounded off. The parapophysis for the capitulum of the rib is midway along the body in its upper half, directly below the transverse process. The transverse process is 50 mm. long, placed above the middle of the body. Its upper surface is flat and horizontal, and its distal end is considerably thickened so that its articular surface is roughly triangular with a width of 36 mm., looking downwards and outwards. The anterior border of the process passes directly into the outer border of the prezygapophysis; its hinder border is proximally emarginate. The width between the facets of the transverse processes is 115 mm. The prezygapophysis extends in front of the centrum, and is double the length of the postzygapophysis. The general shape of the processes is of the normal Plateosaurian type.

Two other dorsal centra are preserved (Cat. No. 3356) having the following measurements:

Length	105 mm.	110 mm.
Height of anterior end.	86 ,,	90 ,,
Height of posterior end	78 ,,	82 ,,
Width of anterior end.	68 ,,	72 ,,
Width of posterior end	63 ,,	72 ,,
Median width . .	30 ,,	37 ,,

Caudal. There are two imperfect caudal vertebrae, both from the mid-caudal region. One is 67 mm. long, has the anterior end of the centrum 52 mm. high and 48 mm. wide, the posterior end 50 mm. high and 44 mm. wide, and is considerably constricted in the middle width a minimum width of 24 mm. The ends are somewhat concave and the ventral borders of the ends are bevelled off, the anterior more than the posterior. The anterior zygapophysis are small and upwardly directed. The transverse processes arise at the top of the centrum and stand out horizontally.

In the other, the centrum is 75 mm. long with its end 48 mm. high and broad. It is but little compressed and the ventral surface is flattened. The prezygapophyses are directed strongly upwards, while the transverse processes are small and arise from behind the middle of the centrum. In neither vertebra are the neural spines or the postzygapohyses preserved.

Scapula. (Cat. No. 3348.) The proximal part of a left scapula is present, lacking the glenoid cavity and the coracoidal articular surface. The greatest breadth at the proximal end was probably 150 mm. The inner face of the scapula is flat, curving strongly inwards proximally; the outer face is lightly convex. Above the glenoid cavity the bone thins rapidly; the anterior border is uniformly thin save for a slight thickening near the coracoid. The supracoraco-scapular concavity is well-marked and large and the deltoid crest strongly developed. There is also preserved a fragment of the upper end which shows that distally the bone was expanded as in *Plateosaurus.* The narrowest part of the bone has a breadth of 71 mm. and a thickness of 24 mm.

Humerus. Two left humeri are preserved, one (Cat. No. 3342) of a larger, and one (Cat. No. 3350) of a smaller individual. The two agree closely with one another in general characteristics, although the smaller bone has been flattened so that the processus lateralis is not so strongly bent as in the larger bone.

From within the bone is seen to be very slightly S–shaped. The proximal part is very broad, the shaft thin, and the distal end broad. The proximal and distal articular surfaces are strongly inclined to one another. The head of the humerus lies somewhat within the middle line. The anterior edge of the proximal articular surface is a regular curve; the posterior edge has two saddle-shaped prominences due to thickenings at the inner angle and at the caput humeri. This latter is at the extreme end of the bone. At the outer side of the broad, concave bicipital fossa is the processus lateralis, a strong crest lying parallel to the inner border of the

upper half of the bone, and whose anterior surface is inclined to the axis of the bone, the upper half pointing medially, the lower end outwards. The lower end of this crest at its junction with the shaft lies half-way down the humerus.

The distal end is broad, but the condyles are not greatly thickened, the whole articular surface being much narrower in comparison

Fig. 31. *Plateosaurus cullingworthi*, Htn.
Humerus No. 3342. $\times \frac{1}{5}$.

with its length than in the European species of *Plateosaurus* or in *Pachysaurus*. Both condyles are somewhat thickened in front, but practically not at all on the posterior face. On the anterior surface there is a marked concavity above the condyles in the median line.

The following table gives the chief measurements of the two bones and compares them with those of the humerus of *Plateosaurus reinigeri*:

	No. 3342	No. 3350	P. reinigeri
Total length . . .	455 mm.	405 mm.	400 mm.
Length from lower end of lateral process to distal end of bone . . .	225 ,,	205 ,,	200 ,,
Length of lateral process	90 ,,	90 ,,	100 ,,
Thickness of lateral process	35 ,,	30 ,,	25 ,,
Distance between upper end of lateral process and inner angle of bone .	155 ,,	186 ,,	180 ,,
Thickness of caput humeri	68 ,,	55 ,,	55 ,,
Thickness of shaft . .	53 ,,	43 ,,	55 ,,
Breadth of shaft . .	63 ,,	53 ,,	—
Breadth of distal end .	166 ,,	157 ,,	140 ,,
Thickness at median condyle	51 ,,	50 ,,	48 ,,
Thickness at lateral condyle	52 ,,	59 ,,	50 ,,
Thickness between condyles	32 ,,	28 ,,	25 ,,

From the humerus of *Gresslyosaurus* the bone differs in that its proximal edge does not form such a high bow, its inner edge is straighter in the proximal half, and the lateral process is much more sharply bent over. The proximal edge is more curved than in the other species of *Plateosaurus* or in *Pachysaurus*; and the distal end is not provided with sharp longitudinal ridges as in *Teratosaurus*.

Radius. A left radius (Cat. No. 3347) has its lower end turned towards the ulna. The upper part is flattened and broadened, having slight median longitudinal grooves on both its medial and lateral surfaces. The proximal articular surface is saddle-shaped, concave in front, convex behind. From the higher posterior angle of the bone a strong crest passes downwards and curves outwards, ending abruptly on the posterior part of the lateral surface 60 mm. down the shaft. The proximal end is 83 mm. long and 43 mm. broad; the distal end 60 mm. long and 53 mm. broad. The narrowest part of the shaft has a diameter of 35 mm. The distal end is trapezoid in shape, and its posterior half is obliquely inclined upwards and backwards.

Ulna. A left ulna (Cat. No. 3351) is compressed from side to side, slightly bent with the medial face convex. The proximal end is bent forwards and has an anteriorly directed prominent point. The hinder portion of the proximal end is slightly higher than the anterior portion, forming an incipient olecranon process. The lateral edge of the articular surface is 108 mm. long and is slightly concave. From the

median angle to the anterior point the length is 88 mm., and to the posterior corner 68 mm. At the broadened end of the shaft the lateral surface is concave, while below it is flat; the medial surface is convex. The distal end is 70 mm. broad and 40 mm. thick. The whole length of the bone is nearly 300 mm. In general aspect the bone approximates closely to that of *Plateosaurus* except that the anterior portion of the upper articular surface is longer and narrower.

There is also preserved the proximal end of another left ulna somewhat smaller than the other. The median angle is slightly more forward, the distances from it to the anterior and posterior points being equal.

Ischium. A right ischium lacking the posterior end and the pubic articulation, and the iliac articular portion and the distal end of a

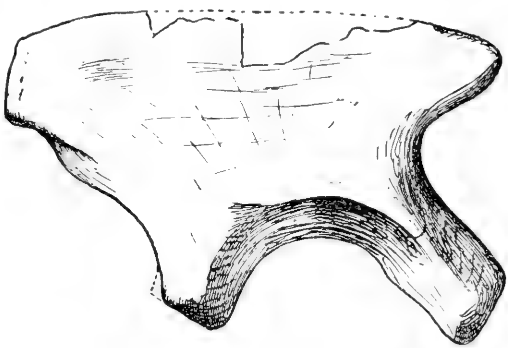


Fig. 32. *Plateosaurus cullingworthi*, Htn.
Right ilium No. 2780. × $\frac{1}{5}$.

left ischium probably belong to this species. The whole length of the bone was probably between 370 and 400 mm. The iliac articular surface is 135 mm. long and 85 mm. broad. Its inner edge is straight, its outer edge regularly convex. The groove on the hinder portion of the bone is not very pronounced. It begins 100 mm. below the proximal end. The broken end of the style shows a triangular cross-section, the medial face being 70 mm. long and the width of the bone 40 mm. The anterior angle is more acute than the lateral. The distal end of the bone — as seen in the fragment of the left side — is but slightly swollen. The posterior border curves slightly forwards distally. At the extreme end the inner edge is 95 mm. long and the bone is 63 mm. thick.

Femur. Two right femora (Cat. Nos. 3602, 3603) have been built up from fragments found weathered down the slopes. One is larger

than the other, but the two are of closely similar shape and proportions.

The larger (3602) has a length of 600 mm. The breadth at the proximal end, from the border of the caput femoris to the lateral border is 175 mm. The proximal end is strongly rounded, and its shape approximates closely to that of *Plateosaurus erlenbergensis.* The upper end of the bone is 85 mm. thick, but it is compressed between the upper surface and the trochanter major. At the trochanter major

Fig. 33. *Plateosaurus cullingworthi,* Htn.
Right ischium. $\times \frac{1}{5}$.

it swells again, but not to such an extent as in *Euskelesaurus.* The shaft is slightly S-shaped.

The lower end of the 4th trochanter lies 305 mm. below the top of the bone. The trochanter is slightly curved, concave medially, and lies nearer the medial than the lateral side of the bone. The distal end is broadened and thickened. The medial condyle is considerably larger than the lateral. Above the condyles on the hinder face the intercondylar fossa is shallow and broad; between the condyles it is narrower and deeper. The medial condyle is a large rounded

boss. The lateral condyle is equally high, but it is narrower, and from it a well-marked fairly sharply rounded ridge passes on to the hinder face of the bone. The anterior face of the bone is flat in its lower half. The lower articular surface has a maximum width of 175 mm., and a height of 105 mm.

The femur differs from that of ***P. stormbergensis*** in the position of the 4th trochanter and in the greater thickness of the caput femoris.

Tibia. The right tibia (Cat. No. 3341) is a complete bone, whose total length is 440 mm. The proximal surface has a length of 175 mm.

Fig. 34. *Plateosaurus cullingworthi*, Htn.
Right femur (3602). $\times \frac{1}{10}$.

from the median condyle to the anterior point, and a maximum breadth of 99 mm. The surface is higher on the inner border than on the outer. At the distal end the anterior process stands at least 50 mm. higher than the narrower, prominent posterior malleolus. The anterior border of the distal end is 111 mm. long, the inner border 83 mm., and the posterior border (parallel to the anterior) 76 mm. long.

This bone is shorter than the tibia of *Gryponyx africanus*, but is much more robust. The head is the same length but wider. The distal end is very much stouter.

Metatarsals. The second and third metatarsals of the right side (Cat. No. 3343 and 3344 respectively) are preserved. The proximal end of the second is quadrangular, having both its longer edges concave. The larger axis of the parallelogram has a length of 92 mm., the shorter 53 mm. From the angles sharp ridges run down the bone. The length of the bone is 216 mm., while the distal end has a greatest breadth of 69 mm.

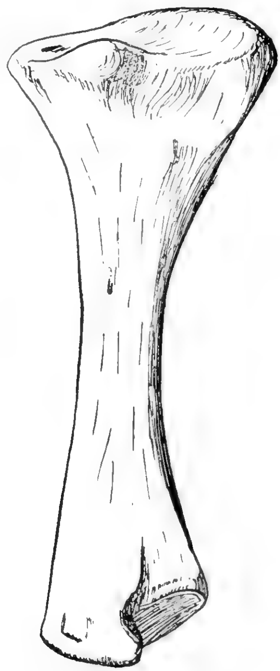


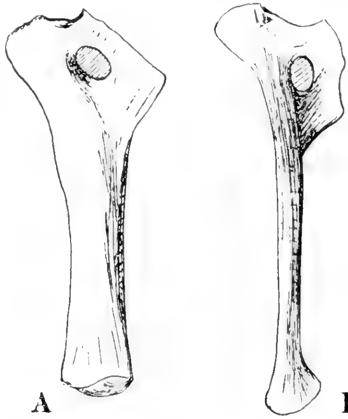
Fig. 35. *Plateosaurus cullingworthi,* Htn.
Right tibia (3341). Outer view.

The length of the third metatarsal is 226 mm. The proximal end is narrowly triangular, 89 mm. long and having a base of 52 mm. The distal end has a breadth of 66 mm.

A number of bones from the Red Beds just above the village of Lady Grey, C. P., seem to belong to this species. They can be correlated with the type by means of a left tibia, somewhat smaller than that described, but of similar shape and relative proportions; a right humerus, of the same size as No. 3350; the distal ends of the two ischia; the distal end of the right and the proximal end of

the left femur, comparable in size with No. 3603; and part of the left scapula. In addition there is an ilium and part of a pubis, together with vertebrae, ribs, and other fragments.

Ilium. The greatest length of the right ilium is 325 mm. Most of the upper border is missing, but it was probably only slightly curved. The posterior process is truncated obliquely, its hinder border measuring 65 mm. The anterior process is fairly long, its lower border rounded, its upper border sharp and thin. The acetabulum is 165 mm. wide and 90 mm. high. The supra-acetabular crest is prominent around the anterior upper portion of the border,



A B

Fig. 36. *Gryponyx africanus*, Br.
Left pelvis of type.

A. Latero — ventral view.
B. Lateral view — ventral surface to right.

rounded on its outer and upper surfaces; but it dies away posteriorly. The preacetabular process is 130 mm. long and 65 mm. broad on the medial face.

Pubis. The larger portion of a right pubis is preserved. It lacks the anterior edge, the distal end and the subacetabular portion. The greatest length of the remainder is 360 mm. The posterior border is strongly concave, so that the plate broadens considerably distally.

Co-types. Portions of two animals in South African Museum. Catalogue numbers as in description.

Locality. Kromme Spruit, Herschel, C. P.

Horizon. Base of Red Beds.

GRYPONYX AFRICANUS, Broom.

Text figs. 36–38.

1911. Broom. Ann. S. Afric. Mus. VII, 4, p. 294. Pls. XIV–XV.

In addition to the original description the following points may be noted.

Vertebrae. Two posterior dorsal vertebrae have been developed. The centra are each 75 mm. long; the anterior articular surface of the first is 55 mm. broad, the posterior surface of the second

Fig. 37. *Gryponyx africanus*, Br.
Left femur of type.
A. Anterior view. B. Medial view.

63 mm. broad and 85 mm. high. The middle portion of the centrum has a minimum width of 28 mm. The maximum height of the vertebra was 180 mm. The dorsal spine is thin, long and fairly low. A figure is given herewith.

Pelvis. The pelvis of the type is crushed, and has been restored and figured by Dr. Broom.

The two pubes form a complete symphysis. They are seen in the type from the ventral side. The greatest length of the left pubis is 440 mm. The pubic neck has a minimum width of 58 mm., and is situated at a distance of 95 mm. from the articular surface for the ilium. Its maximum thickness is not more than 20 mm. At the articulation with the ilium the pubis is 65 mm.

broad. The pubic foramen is large, oval in shape, with a long diameter of 49 mm. and a short diameter of 35 mm.

The pubic plate is long, comparatively narrow and thin — the lateral border sharply rounded and concave, the medial border thin and straight. At the distal end the plate widens and thickens, so that the distal surface is 70 mm. long and 40 mm. wide. At its narrowest part the plate is 55 mm. wide.

Femur. The right femur is markedly S–shaped and strongly bowed, the anterior face being convex. The length is between 535 mm. and 540 mm. The head of the bone is missing. Above the level of the trochanter major the outer edge curves regularly to the proximal surface and is parallel to the inner edge. The top of the trochanter major lies 100 mm. from the proximal surface. The upper end of the fourth trochanter is 175 mm. from the proximal end and the lower end about 260 mm. so that the trochanter lies wholly in the proximal half of the bone.

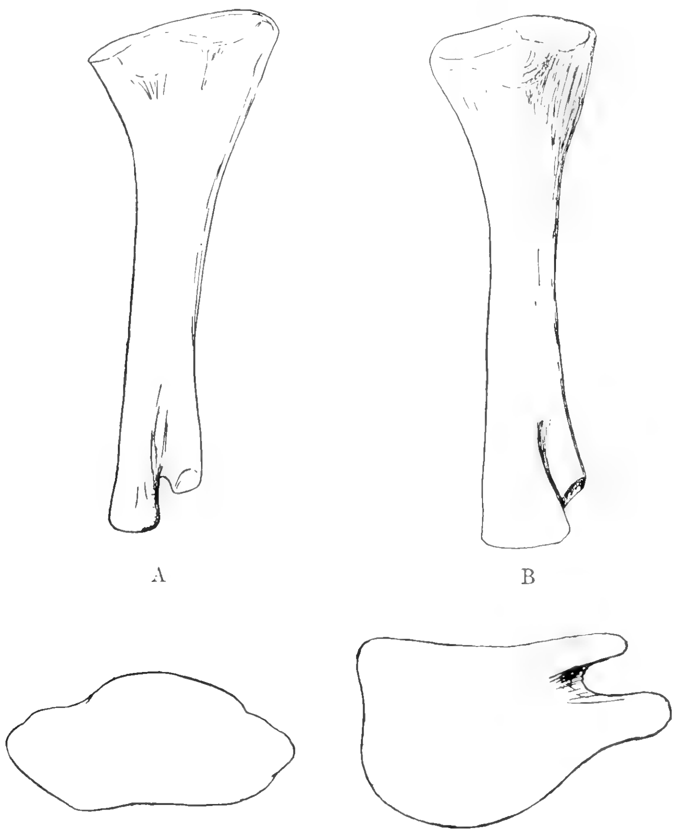
The distal end is 97 mm. broad. The inner edge is 110 mm. long, the outer edge 115 mm. The inner condyle is thicker than the outer, and the sulcus between them is deep and narrow. The ridge running from the outer condyle to the posterior face of the bone is longer and more prominent than that from the inner condyle.

Tibia. Dr. van Hoepen has pointed out that the figure given by Dr. Broom and designated "outer view of left tibia" is in reality an inner view of the right tibia.

The proximal end of the tibia seems to be somewhat flattened from side to side and its width was possibly somewhat greater than the 71 mm. given by Broom. The highest point of the bone lies a little in advance of the anterior corner on the antero-medial border. Instead of the medial border of the proximal end having a regularly convex outline its middle portion is concave. as shown in the figure. The lateral border has a pronounced concavity between the tuberositas tibiae and the lateral condyle. The anterior half of the proximal surface is concave; the posterior portion is also concave, and the two concavities are separated by a saddle. The medial border is higher than the lateral. The shaft narrows very rapidly below the articular surface and expands but slightly distally, increasing only in width and not in thickness. Below the proximal articular surface the lateral face is broadly grooved longitudinally, and separated from the posterior face by a rounded ridge which carries a small boss of bone. The anterior proximal edge of the bone is rugose.

The shaft has a minimum width of 46 mm. and a minimum thickness of 41 mm.

The distal articular surface has a maximum width of 90 mm. and



A B C D

Fig. 38. *Gryponyx africanus*, Br.
Right tibia of type.
A. Latero — posterior view.
B. Posterior view.
C. Outline of proximal end.
D. Outline of distal end.

a maximum thickness of 53 mm. The posterior edge is 70 mm. long. The anterior condyle stands about 45 mm. above the posterior condyle, and its surface faces downwards and outwards. The sulcus between the condyles is narrow and fairly deep.

Type. Pelvis and hind limbs, right and left manus, and vertebrae. (S.A. Mus. Cat. No. 3357, 3358, 3359.)

Locality. Foutanie, Fouriesburg, Orange Free State.

Horizon. Top of Red Beds.

GRYPONYX TRANSVAALENSIS, Broom.

1912. Broom. Trans. Geol. Soc. S. Afr. XIV, p. 82, Pl. XIII, figs. 3, 4.
1920. van Hoepen. Ann. Transv. Mus. VII, 2. p. 102.

This is a very imperfectly known species, the type consisting of a claw phalanx and the distal end of a metatarsal.

The species is apparently about four-fifths the size of *Gryponyx africanus*; according to Dr. Broom "it differs in having a much less developed tubercle for the flexor tendon which makes the flexor surface less curved and gives the whole claw a less hooked appearance". Van Hoepen, however, considers that "the greater part of the tuberositas for the flexor tendon is broken away". He further thinks that the claw belongs, not to the right hand, but to the left; and that it differs from his *Massospondylus browni* (i. e. *M. harriesi*) in that the proximal end of the lateral side ridge lies relatively much higher with regard to that of the medial side in *G. transvaalensis.*

Type. Claw of manus and a metatarsal, in Transvaal Museum.

Locality. Wiepe 1258, N. Transvaal.

Horizon. Bushveld Sandstone.

GRYPONYX TAYLORI nov. sp.
Text fig. 39.

The remains forming the type of this new form were discovered in 1915 in the neighbourhood of Fouriesburg, Orange Free State, in an exposure near the top of the Red Beds. They consist of the pelvic girdle and sacral vertebrae found in conjunction.

Vertebrae. Three sacral vertebrae were found *in situ* between the two sides of the pelvis, somewhat flattened from side to side. The first centrum is not fused to the second.

The second and third vertebrae are of equal length, and each slightly longer than the first. The centra are higher than wide with concave ends. The ventral border of the first is more excavate than those of the other two; the centrum of the third is more excavate posteriorly on its lower border than anteriorly. The lower border of each is sharply rounded, but not keeled nor pointed. The first centrum is 79 mm. long, the others each 84 mm. The posterior surface of the third centrum is 82 mm. high.

The second sacral rib is missing; but it is apparent that the base of the third sacral rib is larger than the second, and the second than the first. Distally the sacral ribs are fused to form one long surface for the support of the ilium. The base of the first lies on the anterior part of the centrum just below the neural arch and only covers a small part of the body; that of the third occupies at least half of the anterior half of the body and extends up to the strong transverse process. Inferiorly the proximal part of this rib is strong and rounded; superiorly it thins considerably and then widens out to meet the under side of the fairly wide, horizontal, and backwardly directed transverse process. The anterior face of the rib is thus fairly strongly concave, the posterior face also being concave, but less so. The first rib is essentially of the same character, but is much smaller.

Of the zygapophyses only the prezygapophysis of the first vertebra is well seen. It is strong with a flat upper surface facing somewhat inwards. The first postzygapophysis is closely fixed to the prezygapophysis of the second vertebra.

The neural canal is high and narrow. The neural spines are higher than the centra, thin, broader above than below, and slightly backwardly directed.

Ilium. The left ilium lacks only the posterior process, which is present in the type of the genus.

The anterior spine is short and sharp, its lower border rounded and fairly thick, its upper border sharp and thin. Its lower border is straight. The preacetabular process is long and strong, widest at the end. In cross-section it is triangular, the apex of the triangle — formed of an obtuse angle — being on the outer side of the bone. The upper half of the process has a strong sharp ridge on its outer edge, which ridge gradually becomes less pronounced as it continues round the acetabular border until it disappears altogether just behind the mid-point of the upper border of the acetabulum.

The postacetabular process is short and broad, its inner surface flat, its outer surface broadly rounded. The hinder border is concave.

The body of the bone thins away rapidly above the acetabulum, and the upper border is bent inwards between the anterior and posterior spines.

The acetabulum is high and narrow. More than half of it is formed by the ilium.

Ischium. The expanded proximal portion of each ischium is preserved. The surface for articulation with the pubis is long and narrows below; both it and the iliac surface are thickened. The hinder surface of the bone is thickened and carries a longitudinal

median groove which dies out about 50 mm. below the posterior upper border of the bone. The anterior border is thin.

Pubis. The left pubis is a long bone with an expanded proximal portion and a thickened distal end. The middle portion is slender, with a rounded and thickened anterior border having no longitudinal

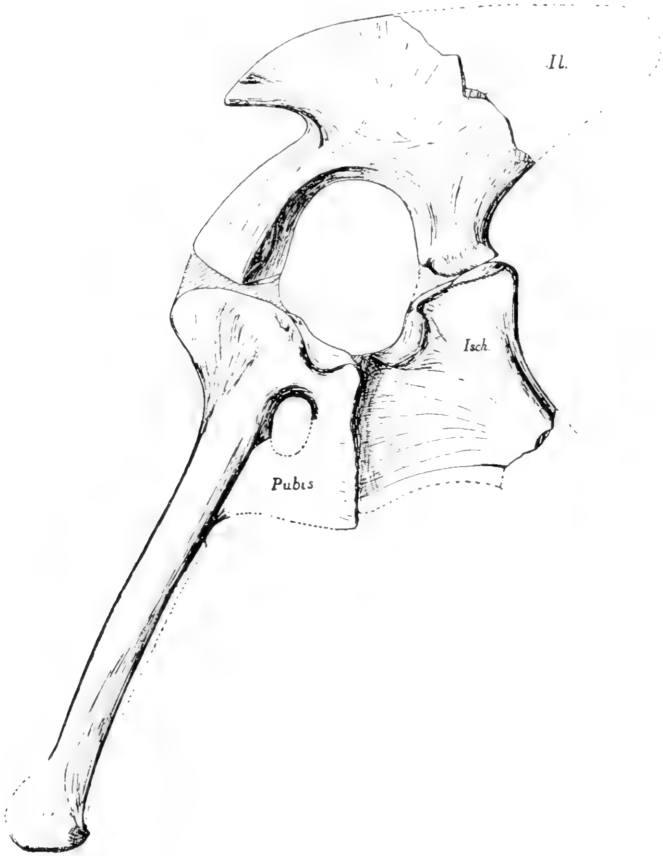


Fig. 39. *Gryponyx taylori,* Htn.
Left side of pelvis. $\times \frac{1}{6}$.

groove, and thinning posteriorly. The posterior border is missing, but the bone seems to be narrower than in Seeley figure of *Massospondylus.* The pubic foramen is large and oval in shape.

The chief measurements of the pelvis are as follows:

Width of acetabular opening . . .	101 mm.
Length of preacetabular process . .	140 ,,

Greatest width of preacetabular process .	71	mm.
Width of postacetabular process . .	56	,,
Length of anterior spine	63	,,
Length of iliac surface of ischium . .	79	,,
Length of ischio-pubic suture . . .	106	,,
Length of pubis	432	,,
Length of iliac surface of pubis . .	80	,,
Thickness of distal end of pubis . .	72	,,

In size this pelvis is almost identical with that of the type of *Gryponyx africanus*, but it differs in the possession of a much larger anterior iliac spine and in the different slope of the upper iliac border, agreeing therein both with *Massospondylus* and *Plateosaurus.*

In his discussion of *Massospondylus* in "Die Dinosaurier der Europeaischen Triasformation" von Huene lays emphasis on the fact that the distal portion of the pubis is short and thick, thus differing from all Plateosaurs. In this specimen, however, the pubis is long and slender distally as in *Gryponyx* and, therefore, the form cannot be placed in the *Massospondylidae.* In spite of the difference in the shape of the anterior spine of the ilium I am inclined to place it in the genus *Gryponyx*, naming it after Mr. H. M. Taylor, while collecting with whom I discovered the remains.

Type. Pelvic girdle and sacral vertebrae. S. Afr. Mus. Cat. No. 3453.

Locality. Fouriesburg, O. F. S.

Horizon. Top of Red Beds.

Euskelesaurus browni, Huxley.

1866. Huxley. Quart. Journ. Geol. Soc. XXIII, p. 1.

1894. Seeley. Ann. Mag. Nat. Hist. Ser. 6, Vol. XIV, p. 317.

1906. von Huene. Geol. und Palaeont. Abh. N.F. Bd. VIII, Hft 2, p. 123.

1911. Broom. Ann. S. A. Mus. VII, 4. p. 292.

The type specimens of this species are in the British Museum and in the Museum d'histoire naturelle in Paris. They consist of fragmentary vertebrae, femur, tibia and fibula, and pubis. The fragmentary nature of these remains renders comparison with other specimens unsatisfactory for specific identity. The type bones have been fully described and discussed by von Huene, who arrives at the following conclusions.

Euskelesaurus browni is not only larger than most other Plateosaurs but there are certain characters which, on the one hand, distinctly

separates it from the other genera, and on the other hand brings it very close to them. The shortness of caudal vertebrae, especially the posterior ones, does not occur to such a degree in other Plateosaurs, likewise the shortness and compression of the phalanges of the foot and consequently also of the metatarsals. The greatest similarity is with *Gresslyosaurus.* The fourth trochanter lies in the lower half of the femur as in *Gresslyosaurus*, certainly rather lower than in that genus; but the whole femur is, in proportion to the enormous vertebral column in its central part, conspicuously shorter than in *Gresslyosaurus* and the other Plateosaurs. The tibia is extremely strong at the proximal end. The dorsal vertebral centrum is higher than in other Plateosaurs. The third sacral centrum is pointed below. The trochanter major of the femur is larger than in other Plateosaurs.

Type. In British Museum.

Locality. "Stormberg", C.P. Almost certainly from the Kraai River.

Horizon. Base of Red Beds.

Euskelesaurus capensis (Lydekker).

1889. Lydekker. *Orinosaurus capensis* Geol. Mag. Ser. 3, vol. VI, p. 353.

1906. von Huene. Geol. und Palaeont. Abh. N.F. Bd. VII, Hft. 2, p. 129.

This is known only from the proximal end of a tibia and a small portion of a femur. It is larger than the type species. The form of the proximal end of the tibia is characteristic, and it is possible that the species is generically distinct from *E. browni.* Too little is known of it, however, to warrant such a separation being made, and none of the bones in the South African Museum collection can be assigned to the species.

Euskelesaurus africanus sp. nov.

Text figs. 40–41.

From Kromme Spruit come a number of large bones found weathered down the slope of the kopje that yielded *Plateosaurus cullingworthi.* Of these, a number of vertebrae, two attached ischia, and some ilia are the most completely preserved. There are also portions of tibiae and of a femur which are, however, not sufficiently complete to admit of satisfactory comparison with those of *Euskelesaurus.* The animals represented by these bones must have been somewhat smaller than *E. browni* and I have therefore decided to keep them in the already-established genus and to designate them as *Euskelesaurus*

africanus n. sp. The type is in the South African Museum (Cat. No. 3608).

Sacral vertebrae. Two fused sacral vertebrae are preserved, lacking the sacral ribs and the neural spines. They are probably the 1st and 2nd sacrals.

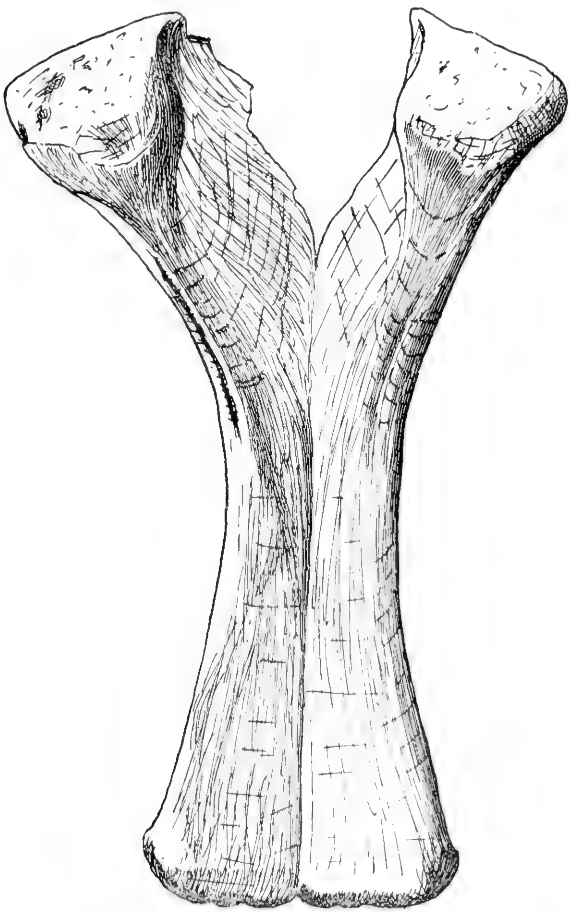


Fig. 40. *Euskelesaurus africanus*, Htn.
Ischia. Posterior view. $\times \frac{1}{5}$.

The anterior centrum has a length of 140 mm.; its front end is flat and has a height of 120 mm. and a breadth of 130 mm. The sides of the body are swollen and the ventral surface is broadly rounded — not so much so as in the succeeding centrum. The sacral rib is represented only by a section across its junction with the body.

This is elongate with a convex anterior edge and a concave posterior edge, while the upper edge is nearly straight and lies just below the level of the zygapophysis. The prezygapophysis is short and its upper surface is concave, looking inwards and upwards.

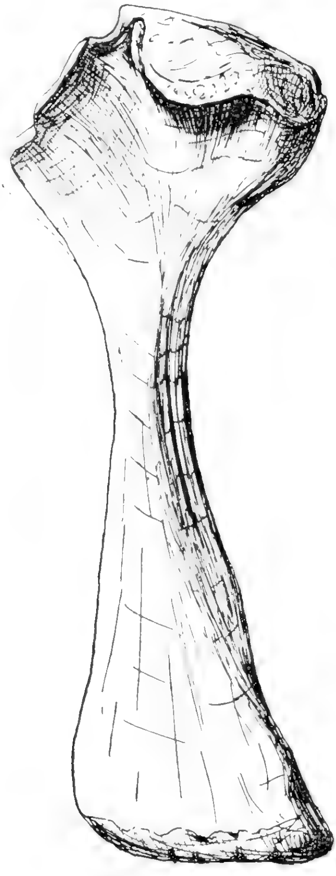


Fig. 41. *Euskelesaurus africanus*, Htn.
Left ischium, lateral view. $\times \frac{1}{5}$.

The succeeding centrum had a length of 145 mm. Its posterior face was 130 mm. high and 140 mm. broad. Its ventral surface was very broadly rounded and without any trace of median keel. The sacral rib itself is lacking, but it must have been very large and strong, larger than that of the first sacral. Its base is on the centrum extending over the greater part of the side of the body from

the front to the back and from the transverse process down to within 35 mm. of the ventral surface. The upper surface of the transverse process is flat and horizontal, the process passing outwards and backwards. The posterior zygapophysis is short; its under surface is concave facing outwards and downwards. The base of the neural spine is 100 mm. long and not more than 25 mm. wide. The width between the tips of the transverse processes was probably 290 mm.

Ischium. Both ischia are present, lacking only the subacetabular expansions.

The greatest length of the bone is 570 mm. Ventrally the two bones were probably in contact throughout their length; dorsally the distal ends have a straight contact for 250 mm. and then diverge gradually. Just above the point of contact on the posterior side the shaft has a breadth of 50 mm.; at the distal end it broadens out to 100 mm. The shaft is flat posteriorly, while its outer and anterior borders are concave. The most characteristic feature of the bone is the very pronounced thickening at the distal end — a thickening greater than that seen in any other known Plateosaur. Whereas at its narrowest the bone has a thickness of only 40 mm., just above the distal end it swells to a thickness of 140 mm. and a breadth of 100 mm.

The distance between the inner sides of the proximal ends of the two bones is 140 mm. The medial face of the proximal portion is concave, the lateral face convex. The greatest breadth across the iliac articular surface is 110 mm. The groove on the hinder face of the bone is about 150 mm. long and is well-marked.

Type. Sacral vertebrae, ischia. (S. Af. Mus. Cat. No. 3608.)

Locality. Kromme Spruit, Herschel, C. P.

Horizon. Base of Red Beds.

GIGANTOSCELUS MOLENGRAAFFI, van Hoepen.

1916. van Hoepen. Verhand. Geol.-Mijn. Genoot. Ned. en Kolonien. Geol. Serie III, p. 107, text fig. 3.

Founded on the distal end of a right femur. The bone is somewhat larger than that of *Euskelesaurus*, but is relatively thicker and has a narrower sulcus between the two distal condyles. The chief interest of the specimen lies in the fact that it is of a type that occurs apparently only near the base of the Red Beds in the Cape Province.

Type. Distal end of a femur in the Transvaal Museum.

Locality. Haakdoornbult, 344. Waterberg Dist., Transvaal.

Horizon. Bushveld Sandstone.

EUCNEMESAURUS FORTIS, v. Hoepen.

1920. van Hoepen. Ann. Transv. Mus. VII, 2. p. 93. Pls. XI, XII, XIII fig. 1.

The type of this form consists of the proximal half of a femur, a complete tibia, a proximal portion of a pubis, portions of dorsal and caudal vertebrae and some fragments, of a large form.

In addition to the comparisons made in the original description, the following may be added. The tibia approximates in size to that of *Melanorosaurus readi*, but the proximal end appears to be thicker (although in *M. readi* it is somewhat incomplete). Further, the proximal end slopes down to the shaft more gradually in *E. fortis* than in *M. readi*, and the shaft is more slender in the latter form. The differences, however, are not very acute and may well be merely specific. Until further comparisons are possible, however, there can be no great harm done in retaining separate generic names for the two forms. The femora, as far as they can be compared, seem different. The proximal end is broader in *M. readi*, owing to the fact that the lateral border does not pass so abruptly into the proximal border in *E. fortis*. In the latter, too, the fourth trochanter seems to occupy a slightly more medial position. In the former character, *Eucnemesaurus* occupies an intermediate position between *Plateosaurus* and *Melanorosaurus*.

From *Plateosaurus cullingworthi* the tibia of *Eucnemesaurus* differs markedly in general shape, the shaft of the former being much more slender in its middle portion; the articular surfaces are also of different shape.

Type. In the Transvaal Museum.

Locality. Zonderhout, near Slabberts, O. F. S.

Horizon. Red Beds (probably about half way up.)

MELANOROSAURUS, gen. nov.

This genus is characterised by the following features: Vertebrae lighter and smaller than those of *Gresslyosaurus* and *Euskelesaurus* when compared with the length and size of the femur; humerus with lateral process sharply bent over, proximal edge forming a moderately high bow, less marked than in *Gresslyosaurus*; femur with straight shaft, whose lateral border forms approximately a right angle with the proximal surface at the upper, outer corner, and with lower end of fourth trochanter below the middle of the femur; distal end of tibia broader in front than behind.

MELANOROSAURUS READI sp. nov.

Text figs. 42–47.

The bones forming the type of this species were found on the northern slope of the mountain Thaba 'Nyama ("Black Mountain"), lying between Josana's Hoek and Josana's Nek in the district of Herschel in the Cape Province. They were lying isolated and embedded in a soft red mudstone below a sandstone band not far above the base of the Red Beds. The bones consist of a tibia, a fibula, part of the pelvis, some vertebrae and metatarsals, together with a femur lying partly embedded in the overlying sandstone and the proximal half of a humerus found weathered down the slope. They are in the collection of the South African Museum (Cat. Nos. 3449, 3450). I can collate these remains with no hitherto-known species, and have much pleasure in naming them after Mr. B. Read, former Principal of the Bensonvale Training School, of whose kindness, display of interest, and hospitality I have a lively recollection.

Another individual (S. A. M. Cat. No. 3532) belonging, apparently, to the same species — but somewhat smaller than the type — is represented by some bones excavated below the Rooi Nek, between Kromme Spruit and Majuba Nek, Herschel, from an horizon about one-third the way up the Red Beds. These remains include a scapula and a complete humerus, and thus add to the knowledge of the form.

Vertebrae. With the type several isolated vertebral centra were obtained. The centra are all considerably longer than high. Their end surfaces are oval in shape with the larger axis vertical. One — probably a posterior cervical — has a sharp ventral surface, keeled at either end. The dorsals are rounded below; all the vertebrae are lightly built compared with those of *Gresslyosaurus.* The length of a dorsal centrum is 110 mm., the height of its anterior surface 95 mm.; while the width at the middle of the centrum is 45 mm. The ventral surface of the bone is not acutely concave.

Scapula. Among the bones from Rooi Nek an almost complete scapula is preserved. The bone has been flattened, so that its original curvature is lost. The upper end is somewhat expanded and is thinner than the proximal end. The anterior border is thin. Proximally the posterior border is rounded and comparatively thick, but distally it is thin. The glenoid cavity is not deep, but it is broad and fairly high. The articular surface for the coracoid is very broad. The greatest length of the bone is 450 mm. The width at

the distal end is 175 mm., and that at the narrowest part of the shaft is 75 mm.

Humerus. The Rooi Nek specimen contains an almost complete right humerus. Its proximal edge forms a somewhat higher bow than is seen in the incomplete bone of the type from Thaba 'Nyama; but this latter shows signs of having been somewhat abraded before its final entombment. Nevertheless, the proximal end is not so strongly arched as in *Gresslyosaurus*, and the distal end differs con-

Fig. 42. *Melanorosaurus readi*, Htn.
Right humerus inner view (3532). × $\frac{1}{5}$.

siderably from that genus. The lower end of the lateral process lies nearly half-way down the bone.

The distal and proximal articular surfaces are inclined to one another at an angle of about 45°.

The distal end has been somewhat flattened, but it is broad and thin. The lateral condyle is considerably smaller than the medial,

and there is a well-marked broad depression between them on the anterior face. The posterior surface of the distal end is almost flat, the lateral condyle being somewhat thickened.

The bone is 500 mm. long. The distance from the lower end of the lateral process to the distal end of the bone is 260 mm. The shaft is 55 mm. thick and 67 mm. broad. The distal end is 155 mm. broad, the thickness at the lateral condyle is 65 mm., and at the medial condyle 63 mm.

Radius. The left radius presents no features of unusual interest. It is slightly shorter than the ulna, having a length of 280 mm. The proximal and distal ends are each 89 mm. wide, while the shaft at its narrowest is 43 mm. wide.

There is also preserved a right radius, somewhat smaller than the

Fig. 43. *Melanorosaurus readi*, Htn.
Right ulna of type. × ⅕.

corresponding bone of the other side. It is 250 mm. long. The proximal end is flattened, while the distal end is thicker and stronger. In both bones the proximal articular surface is concave in front and convex behind as in *Plateosaurus* and other forms.

Ulna. The right ulna is complete, being 300 mm. long. The proximal end is expanded and has a triangular articular surface, of which the anterior and posterior angles are sharper than the lateral angle. The anterior point is directed forwards, the posterior one backwards and outwards. The posterior half of the surface is strongly convex in its middle portion, being raised considerably above the

anterior half of the surface. There is thus a strong boss forming an incipient olecranon process. The maximum length of the proximal surface is 120 mm., its maximum width 60 mm.

The posterior border of the bone is bent in an S-shaped curve, the anterior border being regularly convex. In the former feature the bone differs considerably from that of *Plateosaurus erlenbergensis* which has a straight posterior border. The thinnest part of the shaft occurs about 10 cm. from the distal end, where it has an oval cross-section whose diameters are 35 mm. and 45 mm. The distal end is 95 mm. broad.

Ilium. In the Thaba 'Nyama specimen one ilium is complete. In the Rooi Nek specimen one ilium is complete and the other almost so. The shape of the ilium is most like that of *Massospondylus carinatus.*

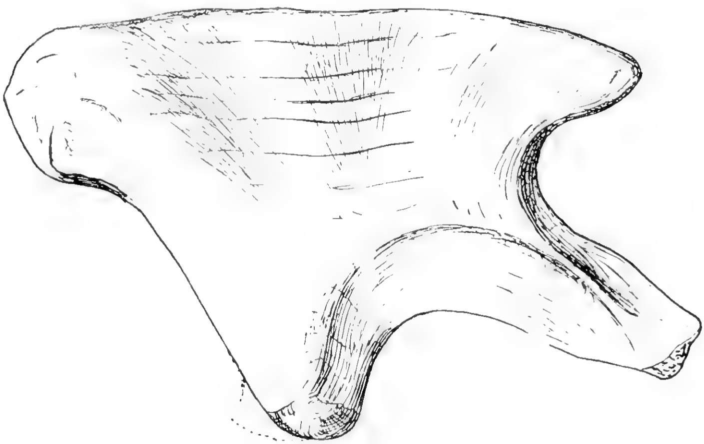


Fig. 44. *Melanorosaurus readi*, Htn.
Right ilium of type. $\times \frac{1}{5}$.

The upper edge is fairly straight and the anterior spine is not so long as in *Gresslyosaurus.* The acetabulum is bounded in its upper anterior quadrant by a sharp ridge which dies away towards the end of the preacetabular process. The postacetabular process is short; its posterior border is straight, except at the lower corner, where it is provided with a hook-like projection. The posterior iliac spine is short and high. The body of the bone is slightly bowed inwards.

The height of the bone from the bottom of the postacetabular process to the upper edge is 275 mm.; the greatest length is 415 mm. The width of the acetabulum is 210 mm., its height 120 mm.

Pubis. An incomplete pubis is preserved, which shows that the anterior portion is a broad, flattened plate.

Femur. This bone was in doubtful association with the other remains, and may possibly belong to another form. It is short compared with the length of the humerus, shorter than in *Gresslyosaurus.* It agrees with *Gresslyosaurus* and *Euskelesaurus* in that the lower end of the 4th trochanter is below the middle of the bone. In outer view the bone is straight and is considerably expanded distally. The width of the distal end at the lateral condyle is greater than that at the medial condyle; the groove between the two condyles is broad and fairly shallow.

The length of the femur is 620 mm., the breadth at the proximal end 170 mm. The lower end of the 4th trochanter is 350 mm.

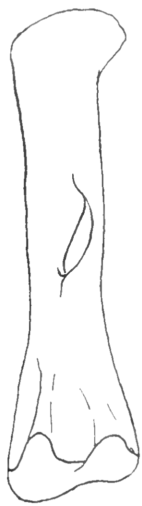


Fig. 45. *Melanorosaurus readi,* Htn.
Right femur. $\times \frac{1}{10}$.

below the top of the bone. The minimum width of the shaft is 95 mm., its minimum thickness 73 mm. The width of the distal end is 175 mm.; the thickness at the lateral condyle 115 mm., and at the medial condyle 80 mm.

This bone, when compared with the tibia, is shorter than in other members of the Plateosauridae. In *Euskelesaurus*, however, where the femur is short and stout, the tibia is not known; but it is possible that the two bones in that genus bear somewhat the same relation to one another as in this form. It is in the size of the vertebrae that the two forms differ so markedly.

Tibia. The tibia is a massive bone 45 cm. long with a large

proximal end, a straight shaft, and a broadened distal end. The tibial tuberosity is weathered away to a certain extent, but must have been prominent. The proximal articular surface has a greatest length of 195 mm., and a greatest width probably of about 100 mm. The inner border does not stand much higher than the outer. The inner border is convex with a shallow concavity at the middle. Between the tibial tuberosity and the anterior and posterior ends of

Fig. 46. *Melanorosaurus readi*, Htn.
Left tibia, outer view. $\times \frac{1}{5}$.

the surface there is, in each case, a shallow concavity. The anterior portion of the surface is higher than the posterior, and is not excessively prolonged, but is bluntly rounded.

Just below the middle of the bone, where it is most slender, the shaft has an antero-posterior diameter of 80 mm., and a lateral diameter of 60 mm. The anterior surface is provided with a sharp keel in its lower half which passes down to the anterior condyle. The posterior surface is rounded, the outer and inner surfaces flattened.

At the distal end the anterior border has a length of 130 mm.

measured along the lower border and stands about 40 mm. above the posterior border, which is 90 mm. long. The inner border is strongly rounded with a length approximately equal to that of the hinder border.

Fibula. The left fibula is preserved entire, although the bone surface is somewhat shattered. Its greatest length is 477 mm. The proximal end is expanded, its inner surface slightly concave, its outer surface convex. The greatest breadth of the proximal end is 140 mm., while it is but 44 mm. thick. The anterior border of this end is thin and sharply rounded, while posteriorly the bone is thicker. The upper edge is higher behind than in front.

The shaft is flat on the inner side and strongly rounded laterally. It has a diameter of 50 mm.

Fig. 47. *Melanorosaurus readi*, Htn.
Metatarsal III. Front view. × $\frac{1}{5}$.

The distal end is slightly swollen in an antero-posterior direction. The lower surface is 85 mm. long and 53 mm. broad, convex on the inner side and obliquely flattened laterally. The anterior face of the distal end is broadly rounded, while the posterior face has a sharp ridge on its inner side, sloping away to the outer face as a flat surface.

Metatarsal. One of the metatarsals is preserved, probably the 3rd. It is a straight bone having a length of 200 mm. The proximal articular surface is triangular, the anterior angle being slightly obtuse. The surface is 80 mm. broad, and has a maximum thickness of 40 mm. At its thinnest part the shaft is 44 mm. broad and 26 mm. thick. The distal articular surface is 62 mm. broad. Distally, the anterior surface of the bone is very flat, while posteriorly it is slightly concave with a shallow wide median groove just above the articular surface.

Type. Incomplete skeleton. S. A. Mus. Cat. Nos. 3449, 3450.

Locality. Thaba 'Nyama, near Bensonvale, Herschel, C. P.

Horizon. Near base of Red Beds.

28

Order ORNITHISCHIA Seeley.

Geranosaurus atavus Broom.

1911. Broom. Ann. S. Af. Mus. VII, 4, p. 306. Pl. XVII, fig. 24.

"The collection of bones consists of badly crushed fragments of a skull with the anterior part of lower jaw fairly well preserved, some slender birdlike hind-limb bones, and a number of very imperfect vertebrae. The vertebrae seem too large to have belonged to the skull, and there being thus some doubt about the bones being those of one animal I think it better to describe the jaw-bones alone and to make them the type.

As preserved, the lower jaw has the left dentary fairly complete with a considerable portion of the right and the predentary nearly perfect.

The predentary has its upper surface displayed, which is concave. It is 12 mm. long and the same in width. The outer and anterior edges are sharp and doubtless formed a horny beak.

The dentary as preserved measures 73 mm. in length, and there is probably but little missing from the posterior end. The anterior half bears 9 teeth which have rounded roots in sockets. The teeth in the fragment of maxilla have flat chisel-shaped crowns with the outer face feebly ridged. Probably those of the mandible were similar in this respect. The most remarkable thing about the dentition is that the most anterior of the teeth is larger than the others, and may be looked upon as a canine. The total length of the series is 35 mm. Most of the teeth have a diameter of between 3 and 4 mm., but the anterior tooth has a diameter of 5 mm."

Associated with the lower jaw, on another small slab of stone is the imperfect mould of a tibia, fibula and some of the bones of the foot which bear nearly the same relation to the size of the jaw as does the tibia to jaw in *Nanosaurus*. It seems probable, therefore, that they are of the same species as the type jaw.

The *tibia* is long and slender, apparently agreeing with that of *Nanosaurus* in that it is compressed proximally with a somewhat triangular cross-section, while its distal end is more rounded in section. The proximal end is nearly all preserved. The anterior portion of the articular surface is higher than the posterior part and is considerably narrower, the tuberositas tibiae being well defined. The lateral process is rounded and strong. The shaft is slender; the distal end is only preserved in the form of a mould of the lateral surface. The total length is 146 mm.; the length of the proximal

articular surface was about 25 mm.; the shaft at its narrowest probably had a width of not much more than 10 mm.

The *fibula* lies on the outer side of the tibia and closely appressed to it, crossing it at a low angle. It was apparently shorter than the tibia and very slender, being widened at its proximal end.

Part of the *pes* is preserved, consisting of a small tarsal bone and the most of one digit, probably the second. The *metatarsal* is 19 mm. long posteriorly and 14 mm. long anteriorly, the distal surface being inclined to the axis of the tibial shaft. The whole axis of the digit is inclined to that of the tibia, so that the animal appears to have been digitigrade. The first phalanx is short, its proximal end broader than the anterior end; the second phalanx is 18 mm. long. The claw is incomplete, but was long and comparatively slender.

Type. Incomplete lower jaw — S. Afr. Mus. Cat. No. 1871.

Locality. Top of Barkly Pass, Elliot, C. P.

Horizon. Cave Sandstone (base of).

PART II.

STRATIGRAPHY

Molteno Beds.

The general features of the Molteno Beds are described by Rogers and du Toit in "The Geology of Cape Colony" as follows:

"The Molteno Beds are first met with at a point a little to the east of Steynsburg and form the higher-lying ground in the Division of Molteno; they extend along the fort of the Stormbergen into Herschel, the Orange River Colony, and Basutoland, and along the base of the Drakensbergen through East Griqualand into Natal.

The formation consists of sandstones, shales and mudstones, the softer beds being much like those of the Ecca and Beaufort, grey, greenish or bluish in colour, but without the calcareous concretions so abundant in the lower groups.

Fossil plants are in places abundant, but seem if anything to be more plentiful in the lower half of the Molteno Beds; silicified wood is common in some of the sandstones.

The sandstones of the Molteno beds are quite unlike any that occur in the lower groups of the Karroo system. In general appearance and in the character of the surface to which they give rise, they resemble the Table Mountain Sandstone more closely than any other in the Colony, but they are coarser in grain and much looser in texture. In most localities the quartz grains are coated with a later deposit of quartz with more or less perfect crystalline faces which reflect light well, so that the rock sparkles in the sunlight. To such varieties the term "glittering sandstone" has been appropriately given.

Grains of felspar are abundant in these sandstones, sometimes in such quantity that the rock can almost be termed an arkose. The loose texture of the Molteno sandstone has allowed the felspar to weather considerably, and the dull white grains of weathered felspar are always conspicuous constituents of the sandstones, more especially in the finer grained varieties. Rounded or spherical nodu-

les, hollowed out in the centre when the hard outer shell has been broken through, are quite a characteristic feature of the Molteno sandstones. The nodules are formed by the oxidation of pyrites and the deposition of some of the resulting iron compounds in a spherical zone about the lumps of decomposed sulphide. The hard shell is thus due to the addition of the hydrated iron oxides to the cementing material usually present.

The lowest of the coarse glittering sandstones has been termed the "Indwe Sandstone", and forms a reliable bench-mark from which the horizons of the different coal outcrops can be defined.

The finer grained varieties of sandstone . . . . are of a yellowish grey or cream colour and furnish a good building stone.

The coarse gritty sandstones occasionally become conglomeratic, the pebbles consisting principally of vein-quartz and of quartzite.

A peculiar feature is the occurrence in the Molteno sandstones of smooth rounded or oval pebbles usually a few inches across but occasionally ranging up to boulders a couple of feet in diameter. They are, as a rule, scattered irregularly through the sandstones, but in the Molteno Division they are particularly abundant along a certain horizon and form a bed of conglomerate a few feet in thickness. The pebbles are sometimes found resting upon a coal seam and partly imbedded in the base of the sandstone overlying the coal. The pebbles are almost entirely of white or brownish, sometimes glassy, quartzites like those of the Witteberg or Table Mountain series. They are most abundant to the south-west of the Stormbergen. Some of these pebbles show pitting externally due to the formation of cubes of pyrites a layer of which occurs just below the surface.

In the Molteno Beds there are numerous outcrops of coal, but the workable seams are restricted to three well-defined horizons. The lowest one is that of the Indwe seam; to this belong the coals at Indwe, Cala and that near Engcobo. The second is about eighty feet higher and is known as the *Guba seam*. The uppermost is the horizon of the *Molteno seam*, 300 ft. above the Indwe seam.

The layers of coal seldom exceed twelve inches in thickness (in the Guba seam there is one about 25 inches thick), but as several usually occur alternating with thin bands of black shale it is possible to extract from three to four feet of coal in mining operations.

On all three horizons these composite seams appear to occupy a number of detached areas, in between which the coal is either replaced by shale or else is entirely absent. In most cases this is due to non-deposition of carbonaceous material, but sometimes to

erosion of the matter deposited, contemporaneous erosion, a phenomenon which is seen in thousands of cases throughout the Karroo beds. At Indwe the upper layers of coal and shale are in places missing, and the surface thus denuded is overlain by massive sandstone with pebbles at its base.

The coals of the Molteno beds are usually laminated and contain very thin streaks of shale; they are coals which where formed very probably at a considerable distance from the spot where the plants grew, and the alternation of thin layers of coal and silt evidently points to the vegetable matter having been deposited over the floor of the basin in the same manner as the silt."

In addition, it is well to give a few details with regard to the stratigraphy in the various Divisions in which the beds have been studied.

Glen Grey, Queenstown & Wodehouse Divisions. In this area the Molteno Beds are essentially arenaceous in character more so than in the country to the north. The Indwe Sandstone forms the most important subdivision, and sometimes the second thick sandstone from the base, the Gubenxa Sandstone, can be identified. There is a general thickening of the beds towards the south and south-east, as is evidenced by the fact that the thickness of the strata below the Indwe Sandstone is 150–250 feet in Aliwal North, 450–500 feet at Sterkstroom and Indwe, 700 feet at Cala, and 1000 feet at Lady Frere.

The Indwe coal-seam is composed of a number of bands of coal and shale, which are constant in character throughout the Indwe mining area. The upper layers were in certain spots removed by contemporaneous erosion. The "wash-outs" must have been formed, according to Du Toit, by streams or currents of water flowing over the seam of coal and shale while they were in a soft incoherent state. The sandstone underlying the coal undulates, and thin layers of coal and shale were spread over the surface and perpetuated the irregularities beneath them. Erosion was most vigorous in the original gentle troughs of the seam, and thus the top coals in these troughs are no longer present, their place being taken by sandstone and grits.

In the Northern portion of Wodehouse near the top of the Beds is a hard fine-grained white sandstone with a few *Thinnfeldia* fronds. A similar bed is found at the same horizon in Elliot.

Aliwal North & Herschel. The thickness of the Molteno Beds in these Divisions is probably about 1000 feet. The Indwe Sandstone

lies about 200 feet above the upper limit of the Burghersdorp Beds and forms a very prominent horizon, showing the same characters as in the south. The Indwe Coal is not present, except that it is represented in places by a hard black carbonaceous sandstone with thin streaks of coal. The Cala and Gubenxa coals are represented by 8 feet of mixed coal and shale. These lie 300 feet above the Indwe Coal.

The upper beds are very similar throughout and consists of coarse-grained pebbly sandstone, usually finer in texture than is the case further south at Indwe in the Transkei. Higher up are fine-grained sandstones with shales and mudstones, sometimes reddish in colour, followed by soft pinkish felspathic grits.

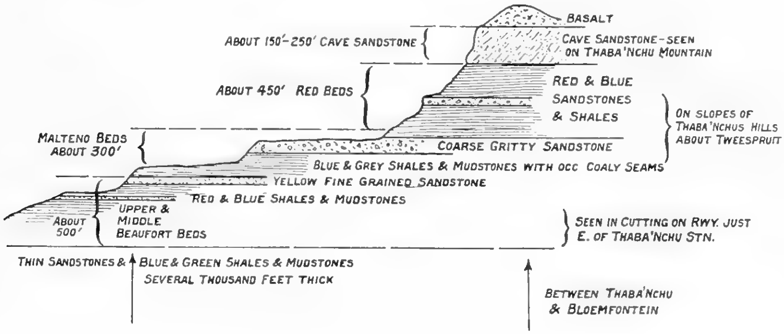


Fig. 48. Section in Thaba' Nchu District, O.F.S.

Orange Free State. Little detailed work has been done on the Stormberg Beds which lie in the Eastern Free State between the Orange River and Harrismith. It is certain that the Molteno Beds are absent at the latter place where the Red Beds rest unconformably on the Upper Beaufort Beds; and there is probably a gradual thinning out of the formation northwards from the Orange River, similar to that which has been traced by Du Toit in Natal. At Thaba' Nchu the beds are about 300 feet thick; the lower two-thirds, according to a section supplied by the Irrigation Department, consists of blue and grey shales and mudstones with occasional coaly seams, the upper third of coarse gritty sandstone. At Verkijkersberg, S.W. of Memel, in the extreme north-east of the Orange Free State, the Molteno Beds are also absent.

Transkei. In the Transkei the maximum thickness varies from 1800 feet in the south of the area to 1400 feet in the north. The Beds are essentially arenaceous. They consist of thick layers of coarse

pebbly felspathic sandstone separated by bluish and grey softer weathering, fine-grained sandstones, mudstone, and shale. The sandstone contains a good deal of felspar, fragments of which are frequently $^1/_4$ in. in diameter, while the grains of quartz frequently exhibit partial restoration of the crystal faces, giving rise to "glittering sandstones". Small pebbles of vein-quartz are abundant in certain layers. Sporadic pebbles of granite, graphic granite, and white fine-grained quartzite occur, more commonly near the base of the series and frequently just above, or even resting on, a coal seam.

The Indwe Sandstone and Gubenxa sandstone are well represented. The top of the series here is a more than usually coarse pebbly sandstone.

Griqualand East. Du Toit has described the Molteno Beds in this area from the Divisions of Maclear, Mount Fletcher, Qumbu, and Mount Frere. The beds bear a close relation to those in the Transkei. In no place are they more than 1800 feet thick and are essentially arenaceous. Iron pyrites is found in irregular layers in the sandstones in a few localities.

Du Toit describes the beds as having the following characteristics. "The sandstones contain a good deal of felspar, usually rather decomposed. The pieces of felspar may, in cases, attain a diameter of half an inch, while in a railway cutting, about a mile south of Ugie Station, small pebbles of granite and graphic granite were observed in addition. The grains of quartz frequently show partial restoration of the crystal faces, and the light reflected from these facets gives the rock a sparkling appearance in the sunlight; hence the appropriate name of "glittering sandstone" given to them. Small pebbles of white or blue-black quartz up to an inch or thereabout in length are most characteristic of these sandstones, and some portions are so pebbly in character that they can almost be termed conglomerates."

Further to the north-east, in Mount Currie on the Natal Border, the thickness has diminished to about 1100 feet, even to 950 feet just over the border. The layers of coarse pebbly sandstone are thinner and spaced closer together than in Maclear. "Otherwise the formation is the same, e.g coarse-grained pebbly sandstones and grits — usually false-bedded and sometimes conglomeratic and crowded with smooth water-worn quartz pebbles — rather felspathic and passing into grey finer-grained types: most of the sandstone sparkles or "glitters" in sunlight owing to the reflection of light from the faces of quartz crystals". The pebbles in the Indwe Sandstone range from a few inches up to a foot in length. At one place there is a ferruginous conglomerate full of quartzite pebbles. Below the Indwe Sandstone

bluish green and grey mudstones and thin fine-grained felspathic sandstones occur. The higher horizons of the Series consist of grits and pebbly sandstones, alternating with blue, grey and buff mudstones and shales.

Natal. Along the eastern slopes of the Drakensberg ranges du Toit has traced the Stormberg Series from the Cape Border to Van Reenen's Pass and Harrismith. At Hlatikulu Hill at the head of the Bushmans River in the Division of Estcourt he has measured a thickness of 140 feet of Molteno Beds consisting almost entirely of grits. At the base the beds are false-bedded with ferruginous nodules; at the top they consist of white coarse grits; and there are few thin shaly beds.

At Bezuidenhout's Pass on the Orange Free State — Natal border the Molteno Beds are absent; and they are similarly absent on the Platberg near Harrismith.

Red Beds.

Elliott. The Red Beds reach their maximum thickness in the neighbourhood of the Barkly Pass where they are about 1600 feet thick. The sandstones are fine-grained and irregularly distributed. Bands up to 30 feet in thickness are common and are usually red or purple in colour when unweathered. Conglomerate beds as a rule are absent; but in one or two localities beds of sandstone contain abundant white quartzite and quartz pebbles. The shales and mudstones which form the bulk of the Red Beds are red, purple, green or white, and occasionally violet in colour. It is noticed that the thicker sandstone bands very often lie upon eroded surfaces of the softer beds.

Wodehouse. The base of the Red Beds contains coarse "glittering sandstones" like those of the underlying Molteno Beds. The thickness in the district is very variable. Just north of Indwe there are 1500 feet of sediments; but 12 miles to the west the thickness diminishes to 650 ft. Further to the south it is again increased. Again, between Dordrecht and Jamestown the thickness is generally 650 feet, while to the north-east in the lower Waschbank it is 900 ft. to 1000 feet.

The lower portion consists of banks of rather coarse-grained gritty sandstone (pale yellow or bluish in colour) with interbedded yellow and buff mudstones and thin purplish red sandstones, shales, and clays. The sandstone beds are thicker, coarser, and closer together than in Elliot.

The upper 400 ft. or so are brillantly coloured shales and sandstones. Calcareous rocks are frequent, occurring usually as irregular nodules and concretions in mudstones.

Aliwal North. The thickness measured at Kraai River Poort is 900 feet, while to the north on the Herschel-Aliwal Boundary and at Lady Grey it has fallen to 600 feet. The general features are similar to those found further south. At the base of the beds a thick yellow sandstone separates the Molteno Beds from the overlying purple and red shales and mudstones. The succession is well displayed at Lady Grey, where Kynaston noted that the sandstones appear to become finer-grained as one ascended in the series. Occasional layers of calcareous concretions occur, which sometimes contain bone-fragments.

Barkly East. Only the top portion of the Red Beds is seen in this mountainous district. The beds have a general dip to the South, whilst to the north in Herschel, they dip in the opposite direction. Du Toit noted the presence of much silicified wood on the farm Glencoe, the tree stems being of considerable size.

Herschel. The Red Beds are well displayed along the north side of the Wittebergen. The thickness at Palmiet Fontein (near the Basutoland Border) and between Kromme Spruit and Majuba Nek is at least 900 feet.

At the base are red and purple mudstones, weathering to light blue, which have yielded a number of large Dinosaur bones. At the summit, at Dulcie's Nek, is a bed of limestone. Between, the strata are made up of very brillant red shales and clays with prominent red and occasionally buff sandstones. The sandstone band which occurs at about one-third the way up the succession as seen at Josana's Hoek appears to be persistent and will probably prove a useful "bench-mark" for palaeontological purposes.

Pebbles are very uncommon in the sandstones. During two fairly extensive collecting expeditions which examined most of the outcrops in the district only two reddish small semi-rounded pebbles of quartzite were seen.

Fossil wood is found in certain localities, occurring in the thin sandstones. Some of the trunks are large One section 9 feet long now in the South African Museum has a diameter of over 2 feet. It was found near the base of the formation at Kromme Spruit lying in a thin sandstone at a low angle to the bedding planes. Other

specimens of similar and even greater diameter were obtained — also from near the base of the beds — at Blikana.

Orange Free State. The Red Beds are well exposed on the eastern border of this province, being especially well seen between Thaba 'Nchu and Modderpoort, around Ficksburg, and between Fouriesburg and Harrismith. Fossils have been collected at Fouriesburg, but no details of the Beds are available. Red colour predominates, but at Ficksburg the base of the formation consists of very thick grits — which, however, may prove to be a local excessive development of the Molteno Beds.

The Red Beds are exposed on the sides of the Thaba 'Nchu hills

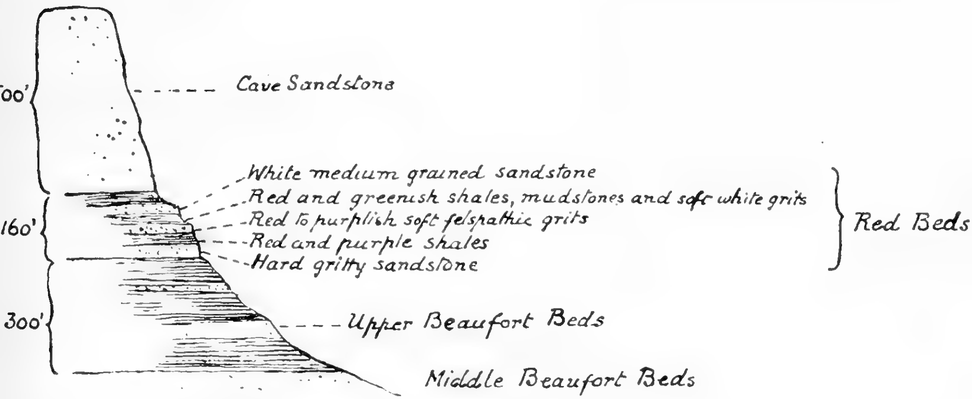


Fig. 49. Verkijkersberg. S.W. of Memel, O.F.S.

about Tweespruit. They are about 450 ft. thick and are predominantly argillaceous, consisting of red and blue shales with at least one prominent sandstone band.

Du Toit has studied the section shown by the Platberg, near Harrismith and he has kindly sent me details of this unpublished study. At the base of the mountain are red and purple shales with medium-grained sandstones, representatives of the Beaufort Beds — a slightly lower horizon of which has yielded a Middle Beaufort fauna on the Harrismith Commonage. Lying above these are 290 feet of strata which he assigns to the Red Beds, there being thus an unconformity between the Beaufort Beds and the Red Beds, the Molteno Beds being absent. At the base of the Red Beds is a thin but gritty sandstone. This is followed in succession by over 100 feet of soft purple shales,

a massive fine-grained sandstone with thin soft bands, and at the top are red and purple shales. It must be pointed out that the unconformity is not evidenced by any apparent discontinuity in succession, nor is there any difference in dip between the two formations.

Further north, at Verkijkersberg, S.W. of Memel, the thickness of the Red Beds has fallen to 160 feet. The red clays of the Upper Beaufort Beds are succeeded by a hard gritty sandstone, often quartzose at the base and this in turn by a fine-grained sandstone. Then follows a series of red to purplish soft felspathic grits, red and greenish shales and mudstones and soft white and red grits. The top of the formation is formed of white medium-grained sandstones. The basal sandstone is variable in thickness and rests sharply on red mudstone:

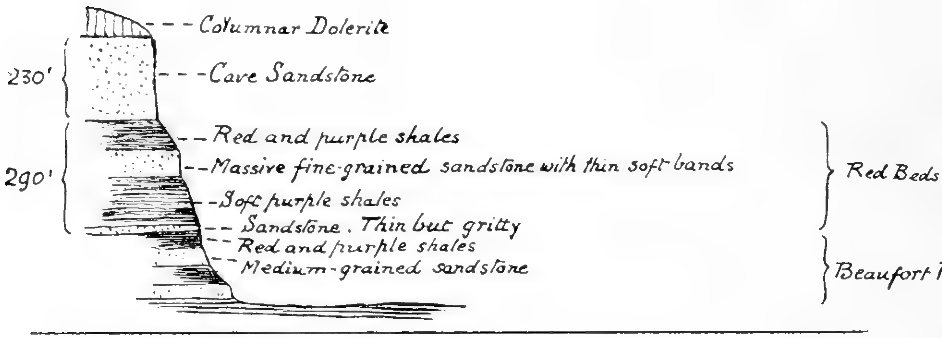


Fig. 50. E.S.E. corner of the Platberg, Harrismith, O.F.S.

portions of it, especially at or near the base, are quartzose grits and show false-bedding dipping in a South-Westerly direction.

Midway between Harrismith and Memel, on Tandjes Berg, the Red Beds are intermediate in thickness.

Transkei. In the Transkei the thickness is uniformly 1200 feet. The sandstones are gritty at the base of the series, occasionally carrying isolated boulders of quartzite; higher up they become finer-grained and yellow. The softer mudstones and sandstones and shales are of brilliant red, purple, and blue tints, weathering pale. Many of the so-called "buff" sandstones owe their colour to weathering, being red on a freshly-fractured face.

Griqualand East. In Maclear and the Divisions bordering it to the North and East the thickness of the Red Beds diminishes from South to North, having a maximum of 1200 feet. Du Toit has described a section showing the full succession shown in the ascent from

Pot River to Tent Kop in Maclear. This shows predominating purple and red shales, mudstones and soft sandstones often of remarkably brilliant colouring — which bleach on exposure. Coarse grits and occasionally pebbly sandstone occur at the base, and not uncommonly there are found boulders of quartzite like those of the Molteno Beds. The most prominent sandstones are usually white in colour, and in places contain nodules of iron pyrites or marcasite. Many of the sandstones when fresh are red; they are commonly full of porous patches which represent spots originally rich in calcareous material. Clay-pellet conglomerates are not uncommon at the base of certain sandstones. Fossil wood is occasionally seen. Vertebrate fossils are scarce.

In Mount Currie the thickness is only 400 feet. The beds, as else-

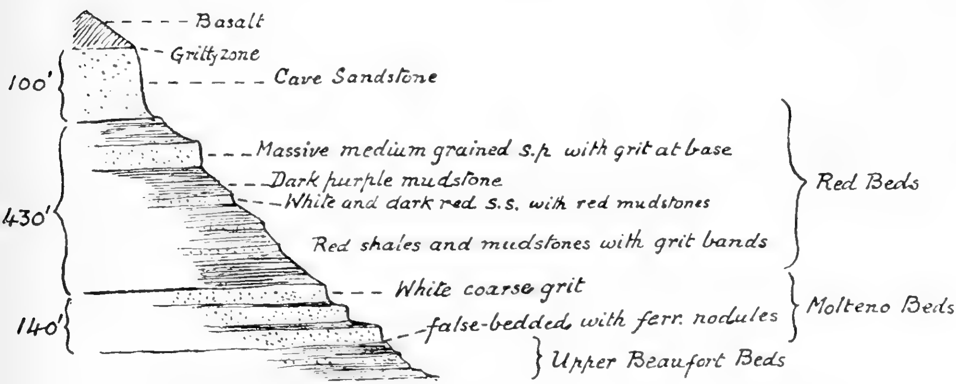


Fig. 51. Hlatikulu Hill, near Table Mountain, Natal

where, consist of several bands of fairly fine-grained sandstone alternating with blue, red, and purple mudstones and soft sandstones.

Natal. At Hlatikulu Hill the Red Beds have a thickness of 430 feet resting on the Molteno Beds. Shales overlie the top white coarse grit of the Molteno Beds, and contain one or two gritty bands. They are succeeded by white and dark red sandstone with red, purple and blue mudstones and soft sandstones; these by dark purple mudstones. Then comes a massive medium-grained sandstone with grit at the base, and between it and the Cave Sandstone are reddish shales.

Further north, at Bezuidenhout's Pass on the O.F.S. border the thickness has diminished to 400 ft. The formation rests directly on purple mudstones of the Upper Beaufort Beds and has at its base a bed of gritty and pebbly sandstone which, in its lower portion, has quartz-pebbles up to $^1/_2$ an inch in diameter as well as pellets of shale and some sandstone fragments. The mass of the Red Beds is made

up of an alternating series of sandstones, which get finer-grained towards the top, and purple mudstones. The sandstones are white and the two uppermost bands contain flattened pellets of pale blue-green shale.

The junction between the Upper Beaufort Beds and Red Beds appears to be an unconformable one, but is without angular discordance.

Cave Sandstone.

Elliott. The Cave Sandstone here is a massive yellowish fine-grained felspathic sandstone of remarkable uniformity of texture. It is slightly stratified at its base, and sometimes more so at its summit; but lamination is usually absent. Some sections show false-bedding on

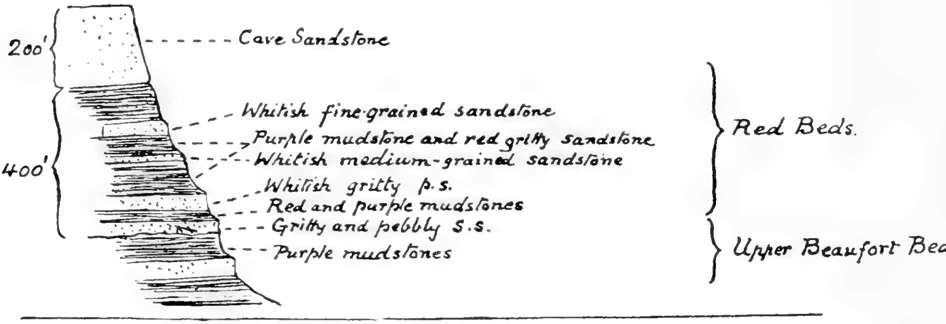


Fig. 52. Bezuidenhout's Pass, O.F.S. border.

an extensive scale. When fresh, the rock is pinkish or reddish in tinge.

Its maximum thickness, as displayed at the Barkly Pass, is 800 feet. Occasionally the sandstone is replaced over short distances by thin yellow sandstones and purple mudstones; similarly in Matatiele it is replaced locally by red clay, often mottled with green or alternating with light blue clay. At the top, the rock is sometimes interbedded with lavas and ash.

Barkly East, Wodehouse, Aliwal and Herschel. In these districts the rock is a fine-grained sandstone, usually pale yellow in colour, but varied by white, buff, pink, and blue. It is generally unbedded, but in places its upper portion is laminated. False-bedding is not uncommon, and is sometimes extensive.

In places the sandstone is split up by layers of ash and basaltic lava. The thickness is very variable, ranging from 150 feet to 800 ft. Du Toit, in his Report on these Divisions, compares the Cave Sand-

stone with the massive white Jurassic sandstone from the Grand Cañon region of Arizona.

Under the microscope the rock is very uniform in texture, chiefly made up of grains of clear quartz only slightly rounded. Angular fragments of orthoclase and microcline occur, as well as plagioclase, small grains of zircon, epidote, and sometimes tourmaline.

At Siberia, in Wodehouse, a shale-band near the base of the formation has yielded a fragmentary fish, many specimens of *Lepidurus*, numerous *Cyzicus* and Ostracods, and several forms of insect. In other places silicified wood is not uncommon.

Structurally, the sandstone is seen to be eroded and faulted before the main outpourings of the lava.

At Lady Grey, Aliwal North Division, where the Cave Sandstone is very well seen, the lower bed of sandstone is approximately 80 feet thick and is underlain by a few feet of soft reddish sandy shales. This bed is without sign of bedding planes, but exhibits well-marked vertical jointing. Above it is 400 ft. of sandstone clearly exhibiting a rude stratification in its upper portion and noticeable false-bedding at more than one horizon.

Orange Free State. Along the western border of the Drakensberg mass the Cave Sandstone constantly appears above the Red Beds. On Thaba'Nchu mountain it varies in thickness from 150 feet to 250 feet. Its thickness at Harrismith is 250 feet, where it is overlain by columnar dolerite, and at Verkijkersberg 500 feet. Its features are constant, a creamy or white massive sandstone forming the main body of the rock. At Fouriesburg the base of the formation is red and purple passing into white, so that it is impossible to draw a lithological distinction between the Cave Sandstone and the top of the Red Beds. From this level have come the types of *Gryponyx africanus* and *Massospondylus harriesi* as well as other lightly-built forms. A shale-band in the Cave Sandstone of Harrismith yielded *Cyzicus draperi* in various stages of growth.

Transkei. At the extreme North-east of the district the formation has a thickness of 800 feet; but a few miles away it thins to 50 feet. There is here an interruption of deposition caused by volcanic outbursts. At Tent Kop the Cave Sandstone is altogether absent, the lavas resting directly upon the Red Beds. These ashes dip beneath the Cave Sandstone of the neighbouring areas.

Lithologically the Cave Sandstone is uniform throughout the area — white to cream in colour, sometimes deep pink or red towards the

base. It is almost invariably fine-grained and is composed of grains of quartz-sub-rounded to angular in outline — with grains of felspar and mica and small crystals of zircon, garnet, and rutile.

Griqualand East. The thickness in this area is very variable. In the North-East, near the Natal border, it has a maximum thickness of 800 feet, while westwards it thins in one place to 50 feet. In the Tsitsana Reserve its thickness is 300 feet yet at places near by falls to 100 feet. This variability is due in part to the outpouring of lavas before the close of the formation of the sandstone — in places sandstone is found intercalated with lava-flows.

The sandstone is generally uniformly white to creamy in colour occasionally being pink or red especially towards the base. The basal portion is well-bedded and at a few places rests unconformably on the Red Beds. The base frequently exhibits false-bedding.

Natal. At Hlatikulu Hill the Cave Sandstone is 190 feet thick, and at the top has a gritty zone overlain by basalt.

According to Churchill (1898) the thickness varies in the stretch between the head of the Bushman's River and Mont aux Sources from 200 feet to 600 feet, while at the south end of Thaba'Mhlope it is 800 feet thick. The rock there is compact, hard and gritty, usually cream or white in colour, but sometimes light red, and occasionally carries a "few round, hard sandstone nodules, often containing a little pyrites". At the base of the formation is a 6 – 10 ft. thick bed of a rather friable, light-coloured marly sandstone resting on a 5 – 15 ft. thick bed of nodular sandstone. This may be taken as the base of the Cave Sandstone as it rests on a "deep, pink, earthy layer".

Transvaal.

The Stormberg Series in the Transvaal is preserved as a number of outliers, forming the Bushveld Series, of which the most important occur on the Springbok Flats, the Komati Poort Coalfield, in the area North of the Zoutpansberg, and in the Limpopo Valley. The features of the series in each of the areas will be briefly outlined.

Springbok Flats. Mellor in 1905 gave an account of the sandstones of Buiskop and the Springbok Flats, which are overlain by the Bushveld Amygdaloid. He stated that the sandstones of the Springbok Flats are universally rather fine in grain and uniform in texture, rarely, if ever, gritty, and contain no conglomerates or pebblewashes except, possibly, at the extreme base. They are peculiarly massive

and homogeneous and only rarely show traces of bedding planes, and then only at wide intervals. The colour varies from deep red to almost pure white or cream. The red sandstone is usually hard and quartzitic; where weathered and soft, it loses its red colour and

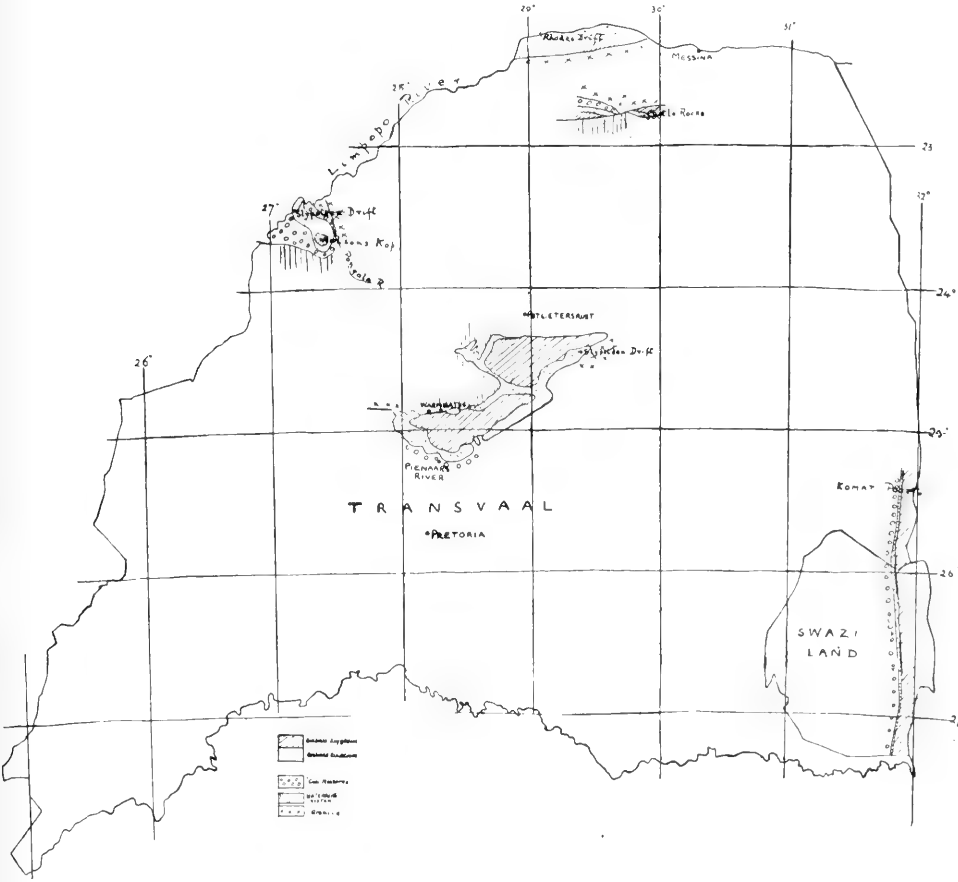


Fig. 53. Sketch-map of Transvaal to show distribution of Bushveld Series.

becomes yellowish or white. The sandstone is distinguished by well-marked vertical jointing.

West of Naboomspruit Station the sandstone rests directly on granite, but elsewhere upon the Coal-Measure Grits. It has a thickness there of about 30 feet. Its upper portion is massive, but towards the base it shows frequent traces of stratification, and the lowest beds consist of distinct bands of sandstones alternating with coarse gritty and

conglomeratic beds which are composed of debris and fragments of granite. In places the fine-grained sandstones lie directly on the granite without intervening conglomerates.

At Slypsteen Drift the sandstones are even in texture, fine-grained and often massive; some beds show a tendency to lamination and are at times false-bedded. Wm. Anderson, in a paper published in 1912, described the occurrence of fossiliferous beds "exposed in the water-channel of the Compies River, in the vicinity of the store at Stypstee Drift, Springbok Flats, Waterberg District". "Stypstee Drift" is presumably a misprint, and should read "Slypsteen Drift". Regarding this occurrence Anderson writes "As this is the only postion in which I observed outcrops of these fossiliferous sedimentary beds, I have no evidence as to their probable lateral extent or distribution, because the country to the north-east, west and south-west chiefly consists of extensive areas of alluvial deposits, through which occasional outcrops of Recent calcareous rocks are not uncommon . . . . To the westward of Stypstee Drift, under the alluvials of the Springbok Flats, these fossiliferous sedimentary beds probably become associated with the amygdaloidal basalts, which form a portion of the Upper Karroo Series, and are well developed in the western and south-western portion of the Flats. It is, however, probable that this occurrence of fossiliferous Upper Karroo beds is not continuous with those of the west, but has been formed in an isolated basin. Similar, probably contemporaneous, sandstones and shales occur at the foothills of the western limit of the Springbok Flats, the sandstones occasionally attaining a considerable individual thickness, as at Buiskop, to the north of Warmbaths, where the rock has been extensively quarried for building purposes." According to Anderson, the beds at Slypsteen Drift rest unconformably on the Red Granite of the Bushveld. In the main section the lower exposed strata consist of practically horizontal exceedingly fine-grained, light grey, argillaceous shales. The sandstones above are markedly false-bedded and much jointed vertically. "In all cases the fossil bones occur as the nuclei of ferruginous nodules and not in a free state in the sediments. They occur more frequently in the nodules from the sandstones, but are more fragmentary than are those from the shale nodules. On all the exposed outcrops these beds do not show the slightest evidences of deposition under violent climatic conditions, although the presence of frequent bone fragments in the ferruginous nodules, which have evidently been much worn by attrition before they were deposited in the sediments, would rather incline one to the idea that there must have been around this lake-basin areas in which considerable

erosion took place, in producing the material for these sedimentary beds. It is, however, difficult to explain why the eroded bones should find a place in these quietly deposited sediments, while the rock products of the same erosion are not present either as conglomerates or as isolated pebbles or boulders". Anderson saw no sign of plant remains; he pointed out that the ferruginous material segregated around the bones which varied in size from an inch to three feet in length. He considered that the bone-bearing nodules were confined to more or less distinct horizons on which the individuals are fairly plentiful. Large bones and small bones are mixed together indiscriminately — the two chief horizons being one amongst the lower shales and the other some distance higher.

Dr. Broom, who examined these remains, could not be certain of their specific identity. He considered it not improbable that they were all representative of one species, pointing out their resemblance to *Gresslyosaurus* and their possible identity with *Euskelesaurus browni* or *Euskelesaurus capensis.*

Neither Mellor nor Kynaston recorded determinable fossils, but in a bore hole at Ludlow 2355 specimens of *Cyzicus* (= *Estheria*) (?) were found in sandstone. Van Hoepen has described also a new genus of Theropod — *Gigantoscelus* — from bones in the Transvaal Museum which came from Haakdoornbult 344 in the district of Waterberg to the west of Pienaars River Station.

Komati Poort Area. The Bushveld Sandstone of the Komati Poort coalfield was described by Kynaston in 1906. In that area, fine-grained sandstones with distinctive features lie between the Coal Measures and the amygdaloidal basalts.

The sandstones are usually without signs of stratification. They are very fine-grained, even-textured throughout, soft, pale greyish or yellowish, sometimes pinkish in colour, sometimes mottled with darker spots. At one outcrop numerous spherical concretions up to 9 in. in diameter were seen, consisting of a hard shell around a softer interior.

Towards the base, the series becomes calcareous, and is often crowded with irregular lumps or nodules of finely crystalline limestone. Below this occur thin-bedded, soft, dark-red and greenish sandy shales and marls, the red colour predominating. The total thickness of the series is 300 feet. No organic remains have yet been discovered in the beds.

Northern Transvaal and Valley of the Limpopo. Mellor, in 1908,

described the geology of the N.W. Zoutpansberg District in a Memoir of the Transvaal Geological Survey. He found that the Bushveld Sandstone series is especially conspicuous along the Limpopo Valley in the neighbourhood of Rhodes' Drift, from which point it extends east and west for many miles, forming prominent ridges rising 200 to 300 feet above the river. The sandstones vary in colour from red to yellowish white, are fine-grained, even in texture and sharp to the touch. They are usually extremely massive and frequently represented by a single bed from 30 ft. to 50 ft. in thickness without divisional planes. Occasionally, however, false-bedding on a very large scale traversing the full thickness of the rock and dipping at angles as high as 20 degrees is brought out by weathering.

Below the upper and harder portion of the massive sandstone and grading upwards into them there is almost invariably found about 15—20 ft. of sandy or marly mudstones, usually light green to purplish in colour, which contain numerous concretionary masses of limestone, varying from an inch to 2 or 3 feet in diameter. This lower marly portion of the sandstones usually weathers out into caves. Downwards the marly rock passes into red or purple sandy shales and soft sandstones, calcareous in places, and frequently mottled with light green patches. The average thickness of this lower series is about 200 feet.

"Where the sandstones form very prominent ridges and kopjes they are frequently found to have been much hardened by secondary silica, usually deposited along the numerous joint planes. In some cases the joint planes and fractures are so numerous that the whole rock becomes a breccia."

Dinosaur remains have been discovered in these beds. On the farm Wiepe 1258, Mr. Bowker found a number of bones which were described by Broom as *Gryponyx transvaalensis.*

In the west of the Waterberg Division of the Transvaal Bushveld Sandstones occur in the area between the Limpopo and its tributary the Pongola and apparently extend a little way across the river into the Bechuanaland Protectorate. According to information supplied by Dr. du Toit the sandstone rests on Coal Measures which themselves lie unconformably on Waterberg Beds or the Old Granite; and Nelson's Kop is capped with a volcanic flow. The Nelson's Kop sandstone — more fully described later — is an approximation to the Forest Sandstone type.

Dr. du Toit has recently presented to the South African Museum a few bones which he obtained from the beds at Slypsteen Drift on the Limpopo. They are, unfortunately, unrecognisable specifically, consisting of isolated phalanges and a portion of a caudal vertebra.

Their size, however, is comparable with that of similar bones of *Plateosaurus* or one of the larger genera of South African Theropoda.

Southern Rhodesia.

Molyneux (Quart. Journ. Geol. Soc. 1903, LIX, p. 279) gave the first provisional classification of the Upper Karroo rocks of Southern Rhodesia. He suggested the following: —

"Thaba 'Sinduna Series	200 ft.	Sandstones and volcanic rocks of Thaba 'Sinduna and Shiloh.
Forest Sandstones . .	1000 ft.	Fine sandstones of the forest-country, with sandy clay. Travertine on the surface. Bubi, Gwampa and Sikonyanla basalts. Conglomerate basement near the Djombi River.
Escarpment Grits. . .	400 ft.	Coarse red sandstones, with subangular pebbles, as seen in the great escarpment which stretches from the Mafungabusi Mountains to near Wankie."

Macgregor (in litt.) says that the beds classed here as Forest Sandstone are largely Kalahari, and therefore of more recent age than the Stormberg.

In an account of the geology of the region round Wankie, Lightfoot (1914) found 100 feet of Forest Sandstones — whose top was not seen — lying on 300 ft. of the Escarpment Grits. The "Forest Sandstone" of this area is said by Macgregor to be equal to his Nyamandhlovu Sandstone. Lightfoot conjectured a break at the base of his so-called Forest Sandstone and, if Macgregor be correct, this break would probably correspond in time to the formation of the Forest Sandstone of the Bulawayo area.

Macgregor (1916) described the Forest Sandstone of the typical area North of Bulawayo. He divides the sediments into four groups;

4. Nyamandhlovu sandstones intercalated in basalts.
3. White sandstone.
2. Red marls.
1. Basal beds, resting on old schists etc.

Maufe (1919) described briefly the Upper Karroo Rocks of the Amanxele Hills in the Bembesi basin north of Bulawayo. There

buff-coloured sandstone lies unconformably on a floor of granite and greenstone schists.

The latest paper by Molyneux (1919) described the succession in the Pasipas area N. of Bulawayo. He divides the sediments as follows: —

Nyamandhlovu group	Arid climate . .	Basalt	30 ft.
		Sandstone	15 ft.
		Basalt	30-100 ft.
	Lava flows and Aeolian sands .	Transition sandstone	40 ft.
Forest Sandstone	Upper division .	Fine, pulverulent sandstone, interstitial clay. . . .	70 ft.
	Middle division .	Marls and sandstones	30 ft.
	Lower division .	Fine calcareous sandstone with calcrete. Limestone . . .	110 ft.
	Basal beds. . .	Partially sorted arkose	10 ft.

In petrological features, the Escarpment Grits consist throughout of a "coarse grey grit, containing banks of pebbles, which are often as large as eggs. It is not bedded very regularly, false bedding being common, and the rock usually breaks along a pebbly bed. The pebbles are all well rounded, and are mostly of quartz, but granite and gneiss pebbles occur occasionally. The rock is well jointed, and the joint faces are usually coated with a dark brown ferruginous skin." (Lightfoot)

The Forest Sandstone of the typical area shows the following features. The *Basal Beds* are conglomerates containing a large percentage of calcium carbonate, and are typically white in colour. Besides containing derived pebbles, siliceous concretions are very plentiful. The under surface of the beds is very irregular and in places the hollows are filled with a fine red marly sandstone lying beneath the conglomerates. In a specimen kindly sent me by Mr. Macgregor a small piece of bone was detected. This is the only fossil so far recorded from this conglomerate. The *Red Marls* have a maximum thickness of 4 feet. They are pinkish red to chocolate brown in colour, laminated, and very friable. Hitherto they have not been found to contain fossils. The *White Sandstone* follows the Red Marls. It is a massive white rock composed of angular grains of sand cemented in an opaline matrix. No bedding planes occur except just

above the marls, where there is evidence of a minor unconformity showing contemporaneous erosion. In one place strong current bedding indicating currents from the south is to be seen. In another place an exposed surface is ripple-marked and apparently sun-cracked. Calcareous concretions and nodules are common. The upper part of the bed is usually dead-white, but it is sometimes stained pale pink. Fossils have only been found at two places. These were vertebrae and portions of a fibula of a small Dinosaur, belonging probably to either ***Thecodontosaurus*** or ***Gyposaurus***. The *Nyamandhlovu Sandstone* is intercalated with sheets of basalt which overlie the preceding bed unconformably. The sandstone is false-bedded, of a deep-red to pale chocolate colour, and generally coarse-grained. It is well laminated and cleaves into broad flags. The grains of the sandstone are well rounded and of fairly uniform size. (Macgregor.)

The Forest Sandstones of the Wankie area, as described by Lightfoot, are much finer-grained than the Escarpment Grits, and contain pebbles only rarely. The sandstone is of a deep red colour and is very much false-bedded, forming flaggy bands. It rests on the Escarpment Grits in irregular patches, some of which are large, and these when viewed from a distance appear to be outliers. In thin section the rock closely resembles the slides made from the stone at Pasipas, near Bulawayo.

The rocks of the Pasipas area were described by Molyneux. He describes the sandstone as made up almost entirely of quartz grains of a common size of 0·2 mm. in diameter, a few reaching 0·7 to 1 mm. The rock is generally soft and easily excavated and, unless indurated by the process of silicification or protected by the sheets of overlying basalt, disintegrates rapidly. The normal rock is composed of fine grains of quartz joined by interstitial felspathic clay in the upper division and by carbonate of lime in certain lower beds. The basal beds generally represent the weathered state of the rocks of the Archaean complex; at other places there is a variable amount of sorting by the action of moving water (storm water). The lower division of Molyneux consists of unbedded deposits either with calcareous cement or lenticular beds of limestone, the deposits being mainly sandstones occasionally with calcareous balls and nodules, with a thin layer of pale brown or pink marl. The middle division consists of coloured marl interbedded with sandstones. The upper division is characterised by the non-calcareous nature of its interstitial clay.

Mennell (1904) says that the sandstone of Thaba 'Sinduna seen under the microscope shows sand grains that are often beautifully rounded and include fragments of perfectly fresh felspar (microline

etc.) which indicates that it is largely of windworn material. A section made from a rock kindly supplied by Mr. Macgregor shows distinctly two sizes of grains — a large rounded grain of diameter about 0·5 mm., and a somewhat polygonal, smaller grain which is also rounded, of about 0·1 mm. diameter. The latter make up the bulk of the rock, which is from Esipongweni, about 20 miles N. of Bulawayo and about 30 feet below the first basalt. The larger grains are nearly all quartz. The smaller grains consist partly of fresh felspar, mainly microcline. Some of the quartz grains show strain shadows under crossed Nicols. There are occasional small grains of apatite and what is possibly tourmaline. The appearance of the grains is closely similar to those of the present-day Kalahari sand, save that there is no ferruginous coating.

Molyneux has pointed out that towards the top of the Forest Sandstone the beds contain increasing quantities of coarser rounded grains mixed with the others. As the Transition Sandstone is reached the grains are still coarser and dark grey in colour and are all well rounded, cohering together by oxide of iron.

Apart from the fragmentary Dinosaurs mentioned, the only Stormberg fossils found in S. Rhodesia are plant remains which have recently been discovered by Mr. Macgregor and have been sent to Professor Seward for determination. I am indebted to Mr. Macgregor for a preliminary note on this occurrence (in litt.). He writes "I had the fortune to obtain some fossils from the lower deposits (at Somabula). There are forms resembling *Thinnfeldia* and *Phyllotheca* so I take them to be Stormberg provisionally. I believe the whole deposit except a surface implementiferous rubble to be Karroo, but there are two types very distinct at Willoughby though interbedded at other places. The older deposits are red and pink mudstones and micaceous sandstones with white fossiliferous sandstones occurring as lenticles, and gravel with very well rounded pebbles at the base. The newer deposits cut channels through the older sometimes into the granite beneath. They are essentially coarse ill-consolidated arkoses with inbedded gravels. The chief point is that the base of the deposits resembles the base of the Forest Sandstone and the upper beds resemble the Escarpment Grits. There is nothing at all like the white Forest Sandstone. The fossils were at the bottom". Macgregor considers the Escarpment Grits to be probably of the same age as the Somabula gravels as they have the same highly rounded quartz and quartzite pebbles.

Finally, Molyneux has seen white sandstone with basalt on top overlying Escarpment Grits in the Mafungabusi district, 60 mile N.N.W.

of Somabula. If this white sandstone is Forest Sandstone, then the succession of the beds seems clear. The Escarpment Grits (with a white sandstone carrying *Thinnfeldia* below them in the Somabula area) are followed by the Forest Sandstone (seen at Mafungabusi), which is white in its lower part and red above, and this passes up by progressively coarser sandstones of more and more rounded grain through the Transition Sandstone into the Nyamandhlovu Sandstone. Where the Escarpment Grits are absent, as in the district north of Bulawayo, the base of the Forest Sandstone is a conglomerate followed by a Red Marl. If, on the other hand, the sandstone of Mafungabusi represents the top of the Forest Sandstone or the Transition Sandstone, then the Escarpment Grits of the Wankie area would seem to equal, in part at least, the Forest Sandstone of the type area. In any case, the correlation with the Stormbergs of the Cape seems clear. *Thinnfeldia* is characteristically a Molteno plant, although it occurs sporadically in the Red Beds; and the Dinosaurian remains are closely comparable with those from the top of the Red Beds or the Cave Sandstone. The lithological changes are also comparable with those seen in the Cape. Coarse pebbly sandstones typically give place to finer-grained sandstones with a local intermediate development of red marls; and the climatic changes are in the same direction as those in the south of the continent, although at any given time conditions seem to have been more arid in the north than in the south.

Writing of the Forest Sandstone Molyneux says "The rocks of the group show none of the usual planes of bedding of aqueous deposits, but are thick deposits of sand grains of uniform size without any sorting of coarser material . . . The basal beds are made up of debris resulting from the weathering of granite *in situ* or which may have been partially sorted into different sizes by storm waters, and in this manner the deeper hollows of the Archaean landscape were levelled up. From this stage onward there is evidence of climate of increasing aridity. The angular shape of the smaller grains in the rock shows that there has, in the lower division especially, been little abrasion or rounding in transport. The deposits are no doubt due to winds that carried dust and particles from a very dry area. To do this atmospheric movements need not have been different from those of to-day . . . The calcrete that occurs in the lowest beds of the Forest Sandstone points to a climate of semi-aridity, but as time went on desert conditions approached and there seems to have been progressive dessication of the whole country. The marls probably resulted from the deposition of fine material through the drying up of standing water — not a lacustrine condition in the manner of lakes

connected with silt-bearing streams, but after the type still known in Africa as that of promiscuous pans or "vloers" described by du Toit. During the stage of the upper division aridity increased; there was not sufficient moisture to segregate the lime, but the vegetation that existed was still of sufficient growth to prevent the accumulation of dunes. But complete desert conditions were not long delayed, for during the transition period the wind-borne debris was sorted by wind rolling into sand dunes. The Nyamandhlovu epoch must have been one of complete desolation. Volcanism manifested itself in the flow of the sheets of basalt of great extent. Dust continued to fall and would be absorbed in the moving lava, but directly that flow ceased in any locality and the surface hardened the wind resumed its work of sorting and rolling, with the consequent formation of the interbedded sandstones." It is worthy of note that the "current-bedding" of the Nyamandhlovu sandstones is paralleled by similar phenomena in the upper portion of the Cave Sandstone, especially when it is interbedded with lava flows.

Maufe has shown that in places where the Forest Sandstone lies on granite and greenstone schist floors, the rock apparently fills up valleys in the old pre-Karroo floors, being in part banked up against the sides of those valleys.

Belgian Congo.

The basin of the Congo forms a gigantic depression which is formed of tilted and folded sedimentary rocks and schists of Palaeozoic and Pre-Cambrian age resting upon Archaean granites and gneiss. At the bottom of this hollow is a series of continental formations which rest unconformably upon the older rocks. These lie, in the main, horizontally or dip at feeble angles. They have been grouped by Prof. Jules Cornet into

3. Lubilache Beds ("Lubilash" of some authors)
2. Lualaba Beds
1. Kundulungu Beds.

The Kundulungu Beds are considered by Cornet to be of "Permo-Carboniferous" age; but the other two groups are thought by the same author to be the equivalents of the Upper Karroo Beds of South Africa, and it is these which must be considered here.

Ball and Shaler (1910) describe the whole series above the Kundulungu as the Lubilache Series with a vertical thickness greater than 1500 feet, while in the Kasai region their Lubilache rests on

old rocks without the intervention of the Kundulungu series, and has a thickness of fully 700 ft. near Luebo and of 800 ft. on Lomani with a dip towards the centre of the basin. Mathieu hints that Ball and Shaler may be correct in surmising that the Lualaba and

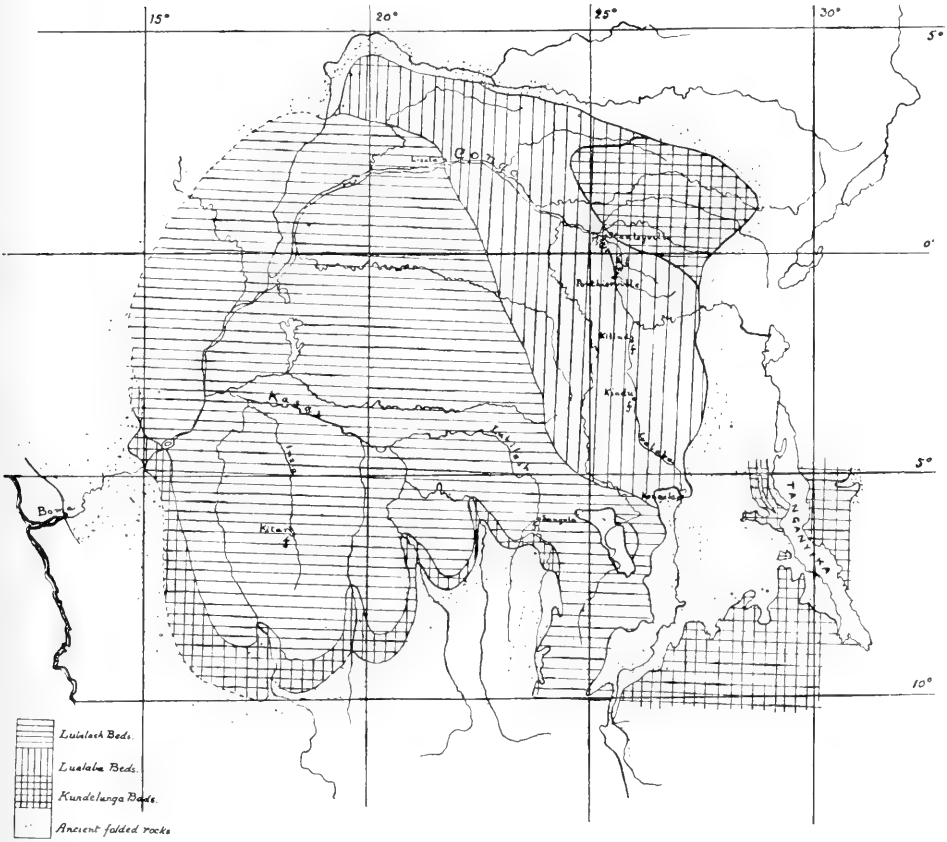


Fig. 54. Sketch-map of Belgian Congo to show distribution of Karroo System (from Revue Zool. Afric.).

Lubilache Beds may possibly be only phases of the one series. Passau, Horneman and others agree, however, with Cornet in separating the two series, and Passau has shown that Cornet separated the Lualaba from the Lubilache by means of a distinct carbonaceous shaley zone below the sandstone of the latter. These carbonaceous shales occur over a wide area, e. g. at Stanley Falls, the Lomani

Valley, at Lusuna and Lusambo along 5° Lat., and also in the east in Kasai.

Lualaba Beds. The Lualaba Beds have been described by Cornet as consisting of clays, grits, sandstones, limestones with little coherence and often oolitic, etc., and have been shown to cover a large area in the Congo Basin.

Studt in 1913 gave the following as an ideal complete section of the Lualaba Beds:

12.	Mottled clays & mudstones — black, white and red .	100 ft.
11.	Coarse red micaceous & felspathic gritty, pebbly sandstones	110 ft.
10.	Greyish calcareous shales & thin aragonite bands . .	10 ft.
9.	Black shales with pyritic coals, & coarse felspathic grits	140 ft.
8.	Light grey calcareous false-bedded & banded sandy shales	80 ft.
7.	Pyritic black shales and gritty sandstones	10 ft.
6.	Light grey calcareous banded & fluted sandy shales .	60 ft.
5.	Red pebbly sandstones, grits & conglomerates with intercalated beds of brown shale	160 ft.
4.	Light pink to grey sandstones & shales	80 ft.
3.	Pyritic black shales & coals with intervening felspathic grits.	120 ft.
2.	Light red to yellow medium-grained sandstones & shales	20 ft.
1.	Grey calcareous breccia.	80 ft.

Studt's bed no. 12 is not the carbonaceous shale mentioned by Passau, and it is possible that his beds 10, 11 and 12 may belong to the Lubilache series.

Passau in a paper on the beds in the area north of the Kasai along the Ulindi and Elila subdivides the succession as follows: —

Lubilache	5. Banded arenaceous shales with indeterminate plants.
	4. Clayey banded shales wlth nodules and pebbles.
Lualaba	3. Black clay shales — graphitic, carbonaceous and micaceous with plant fragments.
	2. Clayey shales with pebbles.
	1. Soft greenish clayey sandstones passing into conglomerate with very large inclusions generally of subjacent rocks.

He states that the Lualaba has a more restricted occurrence than the Lubilache, on account of the overlap of the latter on the former.

Hitherto, the Lualaba Beds have yielded only a few fossils — fish

remains and Entomostraca — which have been briefly described by Leriche.

At Kilindi, at the junction of the Lualaba and Lindi rivers, fish remains were found in a soft, whitish argillaceous-calcareous sandstone which lies horizontally — the "middle calcareous shale zone" of Passau. This zone may correspond with bed 8 of Studt's classification. Leriche described the remains as *Peltopleurus maeseni.*

From white limestones at Kindu on the Lualaba two forms described as *Pholidophorus corneti* and *Lepidotus* (?) sp. by Leriche were obtained. In the latest paper on the Palaeontology of the Congo (1920) Dr. Leriche describes a large number of fragmentary fish remains under the name of *Lepidotus congolensis*, a species already described by Hussakof on material from the Congo basin. These remains are from calcareous clay from near the base of the Lualaba Beds in the vicinity of Stanleyville. He also describes a single scale attributed to *Colobodus* from just north of Ponthierville. Cornet also mentions the discovery of fish debris in bituminous shale in the neighbourhood of Ponthierville.

Entomostraca are common in some localities, e.g. at points on the railway between Stanleyville and Ponthierville, almost covering the surface of the layers on which they are found. Leriche examined them, and described a Phyllopod *Estheriella lualabensis* Leriche, and an ostracod *Darwinula globosa* var. *stricta* R. Jones. This latter variety occurs in the Rhaetic of Scotland and Leriche considers the Congo specimens to be indistinguishable from the Scotch form. The same form also occurs at Songa, 43 km. below Ponthierville, in bituminous shales; on the banks of the Oviatoku (a tributary of the Lualaba) in beds full of the ostracod *Metacypris passaui* Leriche; at Bamanga, 14 km. below Ponthierville; and at Kindu in clear limestones. From a study of these forms Leriche concluded that the Lualaba Beds were of Upper Triassic age. Cornet, on non-palaeontological grounds, correlated them with the Beaufort Beds of the Karroo System, considering, however, that the Lualaba Beds were a complex whole, in which one should be able to distinguish several zones.

Messrs. Ball and Shaler obtained fossils from several localities in the series (which they described under the name of the "Lubilache") viz., indeterminable plants from shale at Niangwe, 200 ft. above the base of the series; ostracods of the genera *Cypris*, *Candona* and possible other Cypridae, a valve of *Estheria*, and fragmentary fish-remains from limey shales 10 miles below Stanleyville and 150 (?) ft. above the base of the series; and a possible *Estheria* valve from soft sandstones at Sangula at the confluence of the Buschinmai and Sankuru

rivers. (Of the organic nature of the last, Cornet is doubtful; and Leriche places the locality in the Lubilash formation). Ulrich, from an examination of these fossils says "The bed from which the fossils were procured is Mesozoic and Jura-Triassic, rather than later." Ulrich further states that if the fossils indicate anything concerning the climate it would be that it was relatively moist and cool, and that the water in which they were deposited was either fresh or brackish.

Lubilache Beds. Studt describes these beds as being "reddish to white friable sandstones and conglomerates containing numerous bands of concretions so penetrated by secondary silica as to have the appearance of pebbles or boulders of granular quartzite, flint, or jasper, while agate, onyx, and chalcedony are also common. The conglomerates "often contain black pyritic shale pebbles." Ball and Shaler also emphasise that "as a rule massive bedding predominates in the sandstones, as does a reddish colour; grayish and white beds are, however, not uncommon". Passau considers the thickness of the sandstone to be from 300–400 metres. In the Lubilash Beds at Kitari, a red shale has yielded numerous carapaces of a Phyllopod assigned by Leriche to ***Estheria*** sp. The same bed has also been said to yield ostracods "recalling *Darwinula globosa*", a variety of which is described from the Lualaba Beds. The *Estheria* is said to be sharply defined from ***Estheriella*** of the Lualaba Beds by the absence of radial ribs. The red shale in which the specimens were found occurs as a thin band in the thick sandstones of the Lubilash.

Correlation of the Lualaba and Lubilash Beds with South African zones is difficult on account of the paucity of the fossil remains from the Congo. Of the fish from the Lualaba the only genus found in South Africa is ***Pholidophorus*** which has been described from the Burghersdorp Beds (Upper Beaufort). ***Lepidotus*** is a Semionotid; ***Semionotus*** is a Cave Sandstone form. ***Colobodus*** is a Trias-Rhaetic genus. The phyllopod ***Estheriella lualabensis*** is apparently close to ***Estheria greyi*** from the Middle Beaufort Beds of Cradock. It seems possible, therefore, that part at least of the Lualaba Beds may be the equivalent of the Middle and Upper Beaufort Beds of the Union.

The lithological nature of the Lubilache Beds suggests instantly correlation with the Stormberg Beds. Cornet first suggested this correspondence, and Maufe and Molyneux both see resemblances between the Lualaba Beds and the Forest Sandstone group of Southern Rhodesia. Maufe writes, in criticism of Studt's later view that the Lubilache was of Waterberg age, "The author's description of the Lubilash Beds of Katanga might well be a description of the forest sandstones of

Southern Rhodesia"; while Molyneux says "I agree that the Lubilash series much resemble (in petrological features) the escarpment grit and forest sandstones. Thus it must be that the Lubilash are my escarpment-forest series, and of Upper Karroo age. The chalcedonic segregations, agates, and other silifications, and the friable nature of his fine sandstones are remarkably akin to features of the forest sandstones of Mafungabusi Mountains, where there is no doubt that they overlie the coal measures." As has been shown, the Forest Sandstone is almost certainly the equivalent of the Cave Sandstone. More palaeontological evidence is, however, greatly desirable, as similarity of petrological features merely means similarity of conditions of deposition and need not of necessity imply similarity of age. The *Estheria* sp. described by Leriche seems to have a fairly close resemblance to the Cave Sandstone form from the beds at Siberia C.P.; and their occurrence in a thin shaley band in massive sandstones is certainly significant when compared with the mode of occurrence of the latter.

Most writers on the geology of the Belgian Congo follow Cornet's original idea of the lacustrine origin of the Lualaba and Lubilache series. For example, Ball and Shaler picture their "Lubilache series" as having been formed in a lake which was probably subsiding in the middle, with low land to the west, north and south but hilly ground to the east — the hills possibly rising to a height of 2000 feet. Between these latter ran valleys, some deep enough and narrow enough to be worthy of the name of "fiords". No where was the lake deep. Cross-bedding was common, as well as abrupt changes from sandstone to shale. There was deep disintegration of the rocks of the shore-line due to weathering. Cornet, however, writing in 1910 remarked with regard to the "Lac Lubilachien" that his views had undergone modification since 1893. The conception of Lake Lubilache was a simple one and provisionally admissible at that time. But the Lubilache series, which is far from being limited to the stretch of the actual basin of the Congo, is much more complex than was at first supposed. It is possibly in part of lacustrine origin; but dunes and aeolian sediments generally play an important role in it. The "gres polymorphes", which are so characteristic of the system are certainly desert formations. Passarge follows Cornet in considering the Lubilache Beds as the products of a desert climate.

GENERAL CONSIDERATIONS.

Cape-Orange Free State-Natal Area.

Molteno Beds. The chief features upon which stress must be laid in considering the Molteno Beds of this area are as follows:

The formation dies out to the North, thinning from 2000 feet at its most southerly outcrop to 140 feet along the northern Natal-Basutoland border and disappearing altogether at Harrismith; so that its greatest North-South extent is just over 200 miles, an average diminution of 10 feet per mile. How much further south it once extended we cannot tell; the supposed occurrence of Molteno beds at the top of the Great Winterberg, on the Fort Beaufort-Tarka Divisional boundary has been disproved by a recent investigation undertaken by the author. But that they extended well south of their present outcrop is shewn by the occurrence on the coast near Port St. John's of a down-faulted patch at least 1600 feet in thickness.

The beds consist of sandstones, shales and mudstones which are gray, greenish or bluish in colour, and lack any prominent calcareous concretions or bands. In the south there is a great preponderance of arenaceous beds, but towards the north the argillaceous deposits play a more important, though still rather subsidiary part; it must be noted that in Natal also the shales are inconspicuous. The sandstones are coarse in grain, loose textured, and contain abundant felspar. In the south they are coarser than in the north. The sandstones occasionally contain nodules formed by the oxidation, and subsequent hydration in the outer layers, of iron pyrites. Occasional conglomerates occur, containing irregular boulders and pebbles which sometimes rest on coal-seams partly imbedded in overlying sandstones. Such pebbles are most abundant to the south-west.

The workable coal seams all occur in the lower portion. The coals are in thin layers alternating with thin black shales. They occupy detached areas, their absence from some areas being partly explicable by non-deposition and partly by contemporaneous erosion.

The only fossils are plants, which seem more abundant in the lower half of the formation. Animal remains have not yet been definitely identified, although Dunn has recorded the presence of bones at Molteno.

These features all point to deposition under deltaic conditions, either those of a true delta or of an aerial delta.

Barrell has pointed out that the determination of ancient true

delta deposits from the study of the strata requires the demonstration of evidence that both subaerial and subaqueous sediments were deposited — the subaerial on the landward side of the strand-line and the subaqueous on the seaward (either marine or epicontinental) side. There can be no doubt that during the deposition of the Molteno Beds the land which furnished the rock-waste lay to the south and possibly in part to the east of the present outcrop; and, if a true delta had existed, subaqueous deposits would be expected towards the north. It would seem, however, as if the greater part of the features of the beds can be explained better by premising merely terrestrial conditions. At any rate, it can be said that terrestrial conditions will explain the features without calling in the aid of any large body of water.

Consider the features of aerial deltas in which purely terrestrial deposits are being laid down. Such features vary according to the nature of the climate, whether it be constantly rainy, intermittently rainy, semi-arid, or arid. The late Joseph Barrell worked out the criteria for each type, and to him we owe the following general survey.

In *constantly rainy climates* the deposits on piedmont slopes brought down by rivers and floods carry a large amount of humus and forest growth. The soil and subsoil are continually wet and drainage carries away the soluble elements. Thus deposits will contain little or no iron, magnesia, lime, potassium or soda and, on the other hand, will be rich in carbon. They will, on account of the diminished evaporation and constant saturation, be white, black, or gray in colour. Coal-seams will be abundant, moisture being necessary for their formation. Barrell says "It may be concluded that the broad association of carbon with sediments which are thoroughly decomposed and leached throughout is the mark of continuously rainy climates which are tropic or at least warm temperate; with sediments which are imperfectly decomposed and incompletely leached the mark of more or less continuously rainy climates which are in addition cool or cold."

When the climate is *intermittently rainy* much of the humus in the soil is yellow or red, and the clays are slightly calcareous. When yellow or brown flood-plain deposits are buried and lithified the up-stream portions will be found somewhat more arenaceous, varying from red to brown sandstones and usually including red, green and occasionally black shales. Over the terminal land portions of the deposit, the sandstones should be finer-grained and the quantity of shales increase, becoming more gray, green and black. Thick wide-spreading coal beds are impossible: but in occasional swampy areas

coaly shales will enclose and preserve the vegetation that grew in the swamps. Elsewhere vegetable growth, being alternately wet and dry, soon decays and is destroyed; casts of leaves and trunks in the lighter-coloured shales and sandstones being the only evidence that remains.

Under conditions of *semi-aridity*, the thorough seasonal oxidation of nearly all deposits except those made in permanent pools, lakes etc. results in the marked dominance of deep-red and brown shales and sandstones, a moderate amount of variegated shales and a few containing carbon. Lime will exist disseminated in noticeable amount through both shales and sandstones, and may occasionally give rise to markedly nodular or solid calcareous strata. The microscope should show a noticeable amount of felspar in the finer portions of the rock, as well as mica. "The most marked chemical distinction of sub-arid flood-plain deposits from those of truly arid regions is found in the small quantity of evaporation deposits of calcium carbonate, gypsum, and salt, but especially of the two latter. Lime may be quite abundant, as shown by the kankar of the Indo-Gangetic plain, its importance depending largely upon the quantity in solution in the river water". In river deposits of semiarid climates casts of logs are most likely to be preserved in the sands deposited in the neighbourhood of stream channels. Away from these channels wetting and oxidation would tend to destroy the logs.

In the flood-plain deposits of *arid climates* fluvial, pruvial and aeolian formations are all of wide occurrence. The most distinctive structures are: (1) the presence of mud-cracks filled with aeolian sands, the mud-flakes being usually polygonal plates upturned at the edges (cf. mud-flats of Orange River, at Kheis, as described by Dr. A. W. Rogers); (2) interbedding of fluvial and aeolian sands; (3) the presence of scattered and facetted pebbles.

It can be readily seen that the features shown by the Molteno Beds are intermediate in character between those postulated for flood-plain deposits laid down in constantly rainy climates on the one hand and intermittently rainy climates on the other. The southern more arenaceous facies represents the upstream portions; the northern the downstream terminal beds. Du Toit has shewn that the thinning northwards to the Natal border is due to actual thinning of the various members, while north of that some of the members (the upper) are missing. This is what would be expected from the supposition of a land to the south contributing rock-waste which was laid down in the form of a fan at the foot of the mountains, the amount of material becoming less as time progressed. The absence

of red sediments and calcareous sediments precludes the possibility of any arid or very dry intervals.

The abundance of felspar in the sandstones proves that decomposition was not very complete, and argues a somewhat cool climate with discontinuous rainfall. The presence of boulders and pebbles can be explained by occasional torrential downpours following on periods of comparative quiescence in which vegetation was able to flourish.

It is possible that part of the lower Molteno Beds at least are formed of material that was accumulated on the land surfaces during Upper Beaufort times. During the comparatively cold periods of the Beaufort fairly deep disintegration of the rock-surfaces to the south took place, resulting in the formation of a mass of undecomposed felspar, quartz and other grains which, on the incoming of Molteno conditions accompanied by earth-movement, formed the material which built up the foundations of the Molteno Beds by transport northwards.

The nature of the coal-seams and of the fossil plants associated therewith is of considerable interest. The conclusion expressed by Rogers and du Toit as to the formation of the seams requires some modification. In the first place the often perfect preservation of the plants, which are mainly delicate and fragile fronds of ferns and fernallies, precludes the possibility of their having been transported far from their place of growth by river-torrents. There is little or no maceration shown by the fossils, except occasionally in the sandstones, and it is more reasonable to suppose that the plants were buried near to the swamps in which they grew and flourished.

Such swamps occupied discontinuous areas in the region; for, although contemporaneous erosion is the explanation of the lack of coal seams in certain parts, their absence in others is most likely due to an original absence of swampy ground. Such discontinuity in swamp conditions is a feature of flood-plains in an intermittently rainy climate rather than in continuously rainy regions. It is just possible that the conditions were nearly the same as those described by Davis from Turkestan where there is an alternation of inundations and drought. During the former, and following it, vegetation temporarily springs up, withers, and gives place to desert conditions until the next flood. Such alternation would possibly result in thin coal seams intercalated in thin sandstones or shales; but conditions of too great dryness would not be favourable to the formation and preservation of plant fossils.

Red Beds. The most striking feature of the Red Beds is the colou-

ration of the sandstones, shales and mudstones which is predominantly red or reddish-purple. Even those sandstones which appear pale in the field prove, when freshly fractured, to have a decided red colour; and frequently, as along the northern face of the Wittebergen near the village of Herschel, and at Lady Grey, the mudstones are brilliantly crimson. In the Herschel division and in Aliwal North, the clays near the base are frequently blue or even grey; but only the few feet or so lying directly above the Molteno Beds show this characteristic; they soon give place to typically red deposits.

The climatic significance of red is a subject which has engaged the attention of several workers, especially in America, where the development of the Permo-Carboniferous Red Beds and the Triassic Red Beds has stimulated research. Barrell, discussing the subject in 1908, considered that red colours of sediments are due to oxidation at the time of origin of the sediments, ferric oxide being a component part of the accumulating deposits. He pointed out that in moist climates, heat and exposure all tended to the production of red soils, but that red was also a feature of some deserts. He concluded that the chief condition for the formation of red shales and sandstones is merely the alternation of seasons of warmth and dryness with seasons of flood, by means of which hydration is accomplished. This supplements decomposition at the source of the rock-waste and that which takes place in transportation in rivers. Wetting, drying and oxidation decompose the original iron minerals and remove all traces of carbon. Red shales and sandstones may thus originate in rainy, sub-arid or arid climates without any close relation to temperature, and typically as fluvial and pluvial deposits upon land; but the origin of such rocks is most favoured by climates which are hot and alternately wet and dry.

The same author in 1913 pointed out that redness in rocks is no criterion for the the separation of humid from arid climates, although red beds are frequently the accompaniments of aridity.

C. W. Tomlinson, in 1906, dealt with the conditions of origin of the Red Beds of Western U.S.A. He states "Where alternations of light- and dark-red strata occur, the more deeply coloured beds are in most cases of finer grain than the others. The occurrence of coarse-grained massive buff sandstones in a series of maroon or chocolate shales has been noted by many writers. This association holds true in many other Red Beds besides the group here under consideration. Thwaites reports it as an almost unfailing relation in the Lake Superior sandstone series of Northern Wisconsin, and Geikie mentions its existence in the Triassic New Red Sandstone of Gt. Britain". Further, "the colour of prevailing red strata in the Red Beds series

is due to the presence of ferric oxide. A grey or green colour signifies a low proportion of ferric oxide, and usually a preponderance of ferrous over ferric compounds". Tomlinson considers the theories which propose respectively that the iron has subsequently been introduced into the sediments from igneous magmas, and that it is due to subsequent deposition from meteoric water; neither of these theories has much evidence in its favour. Wherever intrusions have affected Red Beds, their effect tends to be, not to heighten, but to destroy the red colour; while the more impervious strata are usually redder than the more pervious. The American beds, according to the same author, owe their colouration to the presence of ferric oxide which was transported as such and deposited almost wholly as a mechanical sediment, chiefly as a coating to sand-grains; but beyond saying that the inauguration and cessation of red bed sedimentation was probably connected closely with climatic and topographic changes involved in the orogenic history of the continent no definite statement as to climate is made.

Case has also considered in detail the formation of the Permo-Carboniferous Red Beds of Texas, and shows there is nothing in them to oppose the most generally accepted hypothesis that the red colour owes its presence to the mature weathering of iron-bearing rocks in a fairly humid region, with alternations of relative drought and humidity. The clays of Texas have a solidity and density which would not be present if the colouration were due to oxidation and dehydration of the iron subsequent to its deposition.

Again, in his latest work (1919) he says that flood-plain deposits of arid regions are marked by the presence of highly oxidised or carbonated minerals with a lack of hydrous oxides or sulphides. This is largely due to the normally low water-table, which permits the penetration of air deeply into the soil, and the exposure of the animal constituents to oxidation or carbonation. Also, the lack of vegetation on an arid flat means a lack of carbon. The common result is the prevalence of a red colour, the presence of gypsum associated with the remains of terrestrial animals, and a lack of plant remains.

There is thus a consensus of opinion with regard to the theory that the iron oxide, which gives the red colour, is due to the decomposition and oxidation of iron-bearing minerals and that it was deposited in the red strata mechanically in its oxidised condition; but its presence alone is not sufficient to make any pronouncement as to whether the climate was humid or arid. If the red is not associated with blue or grey or black, then the probability inclines towards the arid climate or, more nearly, the semi-arid.

Attention might be drawn here to the red sandy soil of Bechuanaland as described by Rogers (1906). The sand is often of a deep red colour, almost like brickdust, but on approaching an area in which calcareous tufa predominates the colour is seldom so intense. An examination of the material under the microscope shows that the grains are more or less rounded, especially those of quartz, and vary in diameter from a quarter to 1 mm. in diameter. The red colour is due to a coating of oxide of iron, which is removed by boiling with HCl. The great bulk of the material is composed of quartz grains, which show trains of inclusions and cavities. Plagioclase is not uncommon, and is present in the form of cleavage flakes, with the angles somewhat worn. Chalcedony and agate are rather rare; zircon and magnetite are abundant, while epidote is a common constituent. The composition of the sand shows that it has not been derived from the disintegration of the rocks of the district alone. The felspar and magnetite have been contributed by the disintegration of dolerites. It is probable that the quartz grains have been brought down from the Transvaal and the Orange Free State, Cape and Basutoland by the Vaal, Harts and Orange Rivers. The sand deposited along river-banks will be blown over the country by the prevailing N.W. wind. The decomposition of the diabase and dolerite and of pyrites in shales yield compounds of iron which can be taken into solution and deposited as oxide in the cracks and cleavages of the sand grains and around the grains themselves.

In the Red Beds of the Stormberg Series we find that save for occasional blue clays and whitish sandstones at the base, the various members are all red in colour. Carbonates occur, sometimes freely, as nodules, and in places form beds of limestone.

In the Maclear division, for example, the sandstone is commonly full of porous patches or small hollows representing spots originally rich in calcareous material, with here and there limestone nodules. Gypsum and salt are absent — a feature which distinguishes the beds from the Wichita Series of Texas. Conglomerates are rare, such as do occur being generally at the base of the formation.

At the base of the sandstone layers, however, bands of clay-pellet-conglomerate are not uncommon. Such bands indicate a certain amount of unconformity, the clay-pellets being formed by the rolling and rounding of the possibly dessicated upper layers of partly consolidated mudstone which lie beneath the sandstones. That the mud was dried by exposure before successive sediments were laid upon it is indicated by the occurrence of layers showing sun-cracks (cf examples in the South African Museum from Fouriesburg, O.F.S.);

while du Toit has collected and recorded mudstones from the Red Beds carrying worm-tracks, and the South African Museum possesses examples of large Dinosaur tracks from Morija, Basutoland.

There is a pronounced tendency for the sandstones to become finer in grain towards the top of the series. The author found in Herschel, near the head of Bamboes Spruit, a local development near the top of the Red Beds of a rock which has the appearance of being an ancient silcrete or surface quartzite; and from a slightly lower horizon a slightly reddish quartzite pebble was obtained, about an inch long, wich looked like a "dreikanter" whose edges had been somewhat rounded. Save for occasional silicified logs fossil plants are all but absent (*Thinnfeldia* and *Schizoneura* occur sparingly each having been found hitherto at one locality only); and the fauna is entirely a land one. Here it might be remarked that Tomlinson states "No actual remnants of organic matter are reported to have been found in red strata" — the tendency of organic matter is to turn red into green. It is not known whether this statement still holds good for America; but in the Red Beds of the Stormberg Series all the fossil reptiles, with the exception of some large bones from the base, have come from red clays and fine-grained soft felspathic red sandstones. In most cases the bones are found disarticulated; but at Blikana in Herschel, to mention one instance, a complete articulated skeleton of the smallish form *Massospondylus harriesi* was found lying on its side in red strata. The red muds especially are occasionally spotted, somewhat sparsely, with green; and bones from Fouriesburg, O. F. S. are surrounded by a thin layer of greenish rock; but there can be no doubt the green colour is due to subsequent reduction of the iron oxide by the agency of animal matter after deposition.

Moody (Quart. Journ. Geol. Soc. 1905), discussing the variegation in colour of the Keuper Marls in England, considers — mainly on chemical grounds — that "the variegation of marls is not to be explained by the assumption that bleaching of the red rock has occurred through reduction of ferric oxide and the loss of iron"; and he considers that the even distribution of ferric oxide in the English Triassic rocks is probably due to the action of chalybeate waters permeating the whole of the sandstone and part of the overlying marls. However, the intense colouring of the mudstones as well as the sandstones of the Red Beds of the Stormberg Series and the occasional association of green with fossil bones renders this theory a somewhat improbable one to account for the colouration in South Africa.

Microscopic study of the finer-grained sandstomes shows that the

sand-grains are not of the "millet-seed" type, but are sub-angular in outline with their edges and corners slightly rounded. They are uniform in size; and the ferric oxide acts as a cementing material coating the grains. Mica is commonly present.

All these features agree closely with those postulated by Barrell for flood-plain deposits in a semi-arid climate; the basal portion of the Red Beds thus forming a link with the Molteno Beds — the climate gradually changing from an intermittently rainy to a semi-arid one, the aridity increasing as time went on.

A consideration of the horizontal and vertical distribution of the animal remains is of some interest. The base of the Red Beds has yielded fossils chiefly in the district of Herschel. They are all large, heavy-limbed forms such as *Euskelesaurus browni* and *Plateosaurus cullingworthi* while a little higher in the same area are still large forms such as *Melanorosaurus readi.* As far as we are aware, no small, lightly-built forms have been found at the base of the formation. As one ascends the forms become smaller and apparently much more agile. *Massospondylus* occurs from about half-way up to near the top, both in Herschel and in the north at Fouriesburg. At the latter place it is associated with the somewhat larger but still light-limbed *Gryponyx africanus* and a small *Thecodontosaurus.* The southern end of the mass has yielded little from the base of the Red Beds but large bones have been noted by du Toit in Elliot and Maclear; the small *Thecodontosaurus minor* is from the upper half, as are the extraordinary Cynodonts *Tritheledon* and *Lycorhinus*, while the supposed Predentate *Geranosaurus* is from the summit of the formation. *Erythrochampsa* is from the very top also, and is another very lightly-built small form, characterised by an armoured back.

Two features display themselves in this survey. The first is that the animal type became progressively more agile; the other that the majority of the fossils come from the centre and northern half of the present exposures. This latter feature may be disproved by subsequent finds; the southern portion of the area has not been searched to any appreciable extent: and the outcrops are frequently grass-covered and in bad condition for fossil-hunting. There can be no doubt, however, that the first is of some importance; and it gives assistance to the argument for a climate which gradually became more arid. As conditions became more rigorous, there would have been given an impetus towards agility and the ability to travel longer distances, in search of sustenance; and it is significant that deserticolous animals of to-day are long-limbed in structure.

It seems probable that the various animals did not live far from

their place of entombment. Although complete skeletons are not common — one articulated skeleton only from the Red Beds is known to the writer — the majority of the described forms are known from a number of associated bones, some of which are frequently found still articulated. Isolated bones are rare, and few show signs of rolling or long transportation. At the base of the Beds, remains of several large animals were found together in bluish clay near Kromme Spruit, Herschel — apparently swamp-lovers whose remains were washed by moving waters into some quiet swampy spot: a supposition whose probability is increased by the discovery near by of a large silicified log. In general, the bones of an incomplete skeleton of a single animal occur together in one spot — a fact which would be difficult of explanation if transportion over a long distance be postulated.

Cave Sandstone. We have seen that the Cave Sandstone is a massive fine-grained rock of varying thickness with bedding planes but feebly developed. and that in the basal portion only. The rock is generally white or cream-coloured, but often it is pink or red and at its base is sometimes coloured as deeply as the underlying Red Beds. Athough the massive portion of the formation is unbedded it is often traversed by vertical joints.

The following description by du Toit of a specimen of the Cave Sandstone from Rocky Dell, Maclear, C. P., may be taken as typical of the bulk of the formation. (see Geol. Comm. Rept. 1910, p. 88).

"The rock is composed of grains from ·05 to ·08 mm. across of quartz and felspar, the former predominating. They vary in outline from sub-rounded to angular and are sometimes elongated splinters with sharp edges. Some of the quartz grains are quite clear, others contain needles of rutile and dusty inclusions. The felspar consists of orthoclase and plagioclase, either fresh or clouded — and kaolinised; microcline is absent There are flakes of somewhat altered biotite mica, muscovite mica, and a good deal of secondary white mica (sericite) in the felspar, around quartz grains, and sometimes within the quartz itself. A characteristic feature of the Cave Sandstone is the presence of grains of zircon and in the slide there are a number of worn crystals of this mineral, together with some colourless garnet, and some grains of rutile. The groundmass of the rock is fairly abundant, cloudy and dusty and probably for the most part kaolin; in places it has a pinkish colour corresponding to the pink mottling of the sandstone in the hand specimen". "Another section from the summit of the Hlankomo Mountain, Mount Fletcher,

shows nearly similar features, but microcline felspar is present in addition and the rock contains somewhat more mica".

Two main views have been put forward as to the mode of origin of the Cave Sandstone. We will consider first that of Professor Schwarz as developed in a paper in the Trans. S. Afr. Phil. Soc. Vol. XVI (1905) p. 30.

Schwarz considers that the Cave Sandstone is a tuff, blown out of the volcanic vents which opened the period of Drakensberg volcanic activity, a portion of which still, in some cases, remains in the throats of the vents. "If" he says "the Cave Sandstone was formed before the production of the material in the pipe, then the latter ought to be made up of portions of all the rocks which the vent traverses, but we find that this is not the case, and that the material in the pipe is identical with that of the Cave Sandstone. The Cave Sandstone, however, contains 83·5 % of SiO_2, with grains of quartz, microcline, plagioclase, zircon, rutile, tourmaline, chlorite, garnet and epidote, while the lavas of the Drakensberg — some of which flowed out of the pipes — are basic in composition". Therefore, says Schwarz in effect, the pipes must have tapped deep-seated rocks such as the granites and crystalline schists — outcrops of which occur in Natal — and the triturated material from them forms the Cave Sandstone. The author of this theory does not believe that the Cave Sandstone was formed by ordinary denudation from land-surfaces, as no land surface of a requisite nature was near enough at hand. He agrees that the Molteno Beds are the detritus of a granitic region, presumably of the southern prolongation of the Madagascar ridge; but argues that the break in the deposition of the Molteno Beds marked the disappearance of the source of the supply. In conclusion he states "In the Cave Sandstone we have many peculiar features that could be explained by the supposition that it flowed from the crater mouths as a mud. It is hard otherwise to account for the immense thickness of the embedded mass; it is hard to explain the sudden change of great thicknesses of the white rock to a red clayey material; and still more mysterious is the pseudo-bedding that one can see at N'quatsha's Nek, where the stratification is just such as would be produced had the whole been stirred round in a gigantic pot like a pudding".

The same author, in his "Causal Geology" (1910) speaks of the Cave Sandstone as a "non-volcanic tuff"; and in "South African Geology" (1912) says the Cave Sandstone" consists of rounded grains of quartz and felspar which have been corroded on the surface and enveloped with minute scales of talc; thus the ordinary aspect of a

sandstone is entirely masked and the rock has the appearance of chalk. The sandstone is not an ordinary sediment for the fine coating of talc scales would have been soon rubbed off the sand grains if they had been dragged along the sea floor by currents, and the coating could not have formed after the sandstone was consolidated .... The non-volcanic material torn from the granite walls of the chimneys would issue as fine sand, and the corrosive action of the hot gases in the vent would account for the alteration of the grains on their surfaces".

The features shown by the Cave Sandstone, when considered with the other members of the Stormberg Series, do not seem to call for any such mode of origin as is outlined here. It seems that the presence of Cave Sandstone infilling some of the pipes led mainly to the formation of the theory. Du Toit has studied a peculiar pipe of this nature and has published the following description.

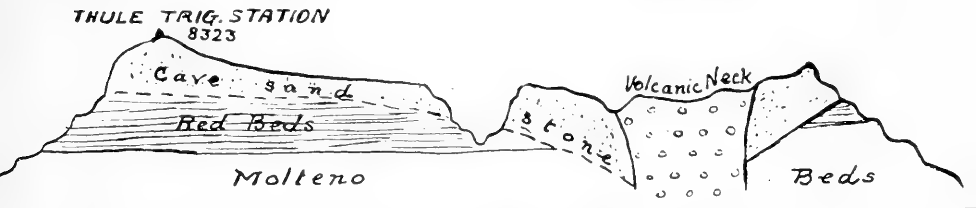


Fig. 55. Diagrammatic section through Volcanic Neck of Thule — after du Toit. Length about 4 miles.

"A very interesting occurrence in view of the information which it yields upon the conditions of deposition of the Cave Sandstone, is the large volcanic neck on the farm Thule (Griqualand East), almost on the crest of the Drakensbergen. It is nearly a mile across with somewhat irregular outline, and occupies a hollow hemmed in by Cave Sandstone, while several narrow ravines have trenched the area and laid bare good sections. The peculiar feature in this neck is that the Molteno Beds and Red Beds are lying quite undisturbed right to the very edge of the pipe, but the Cave Sandstone, on the other hand, commences to show an inward dip at a distance from the margin of the latter, varying from about a quarter of a mile on its eastern side to well over a mile on its west side. The sheet of sandstone curves downward over the denuded edges of the Red Beds, and in places possesses dips of as much as 40°, passing below dark greenish agglomerate at the extreme south-west end, but appearing to abut against the volcanic infilling at other points.

The material within the pipe consists of medium-grained agglomerate with fragments of basalt and amygdaloid of various kinds,

but the bulk of the stuff is of sedimentary origin, and in places it passes into a pale yellowish-green sandy rock with few foreign fragments, some of this passing by degrees into Cave Sandstone. Fragments of Cave Sandstone and red and purple shales and sandstone are present, blocks of basalt up to 6 feet across and lumps of Molteno grit as much as 7 ft. in length.

The history of the pipe must have been somewhat as follows: — At the close of the period of deposition of the Red Beds a small volcano came into action on this spot and gradually enlarged its boundaries, portions of the margin (composed of Red Beds) slipping down at intervals into the vent. Then the Cave Sandstone commenced to be formed and was deposited at an angle over the denuded hollow encircling the agglomerate neck. Sediment would become mingled with the fragmental material within the pipe, while occasional volcanic explosions would account for the ashy streaks and patches in the Cave Sandstone at several points close to and outside the pipe. On the south-west margin the fragmental matter most probably represents an indipping patch of stratified ash overlying the sandstone".

This occurrence is by no means an isolated one; and the matter will be furthered discussed later in the section.

The other difficulties which stood in the way of Professor Schwarz's acceptance of the Cave Sandstone as a product of ordinary denudation seem to disappear if we consider that the climate underwent a further approach to aridity, and that from the onset of Molteno times there was a gradual secular climatic change in one direction throughout the formation of the deposits of the Stormberg Series.

We have seen that the base of the Cave Sandstone is generally red and often bedded — this indicating a continuance of the flood-plain deposits of the semi-arid Red Beds time. The massive portion of the Cave Sandstone has, however, as du Toit (1918) has pointed out, practically all the features of an aeolian deposit such as the Pleistocene loess of the Northern Hemisphere.

In its typical form the loess of Asia and Europe is a fine-grained deposit, consisting of minute particles of hydrated silicate of alumina, quartz, felspar, mica, and other minerals, more or less cemented by calcium carbonate, the segregation of which gives rise to concretions. It is also often impregnated with alkaline salts, and nearly always stained yellow with ferruginous matter. Its homogeneity of composition and structure contrasts it with all water-deposits. There is an almost complete absence of any stratification, and the particles of mica in it are uniformly distributed without orientation. A characteristic feature is its well-marked vertical jointing. Its fossils consist

almost entirely of land animals, distributed evenly throughout its mass. Great numbers of bones of mammals occur locally — mostly belonging to forms abounding on steppes and grassy plains.

The consolidation of such a deposit would very conceivably result in such a rock as the Cave Sandstone. The grains in loess, like those of the Cave Sandstone, are not rounded as those of desert sands, but are described as "angular or sub-angular". One striking difference, however, is in the much greater abundance of hydrated silicate of alumina in the loess as compared with the Cave Sandstone: another in the number of tubules "marking the site of the roots of countless generations of plants"; and a third in the absence of land-shells in the Cave Sandstone.

Taking into account its various peculiarities, von Richthofen concluded that the loess of China is the product of aeolian influences acting during periods of long duration and under different conditions of climate, of which three are distinguished in North China: (1) an erosion period, in which the surface of the country was sculptured by erosion and denudation into the figure it still retains beneath the covering of loess; (2) a Steppe period, in which the conditions of the saline steppes of Central Asia were extended over the whole of Northern China; (3) a loess period, now existing, in which the former Steppe-districts become converted into Loess-districts by the gradual accumulation of dust at the surface, the dust being held in place by the growth of vegetation. This theory of the formation of the loess can be accepted for Northern China; but it does not fit exactly all the requirements of Cave Sandstone formation.

In the first place there is the difference in composition between the two rocks. The Cave Sandstone is felspathic; but the felspar is but little decomposed and there is no such alteration product as hydrated silicate of alumina in any large quantity. Sand grains play the predominant part in the formation of the deposit. The chemical nature of the sandstone and the comparative angularity of its fragments indicate fairly arid weathering of the original land from which the material was derived. In this, there are not true "loess-conditions".

Secondly, there is no indication in the Cave Sandstone of the little tubes representing former grass-roots, nor any sign of extensive vegetation.

Silicified trunks of trees have been recorded from various localities in the Cave Sandstone, as for instance at Morija and Masitisi in Basutoland; but most of the occurrences, together with the doubtful occurrence of coaly material near Belmore, Barkly East, seem to be in the upper, sometimes laminated portion of the deposit.

This may also be looked upon as as mark of aridity. Richthofen considered vegetation necessary for holding in place the dust of which the loess is formed; but this is only so when the area of depositon is itself subject to constant winds. If the dust is deposited as a result of the slackening of the force of the wind which carried it, then vegetation is not a necessary adjunct; and the lack of vegetable remains argues conditions adverse to their growth.

The third difference is the absence of land-shells in the Cave Sandstone. Most terrestrial mollusca require moisture for their development and maintenance; and, although their absence from a land deposit is a piece of purely negative evidence, it lends additional weight to the theory of aridity when so many other facts point in the same direction.

In spite of these minor discrepancies, however, the "loess" seems to be the nearest among recent deposits to which we can liken the Cave Sandstone. It is of interest to note that near the base are highly irregular calcareous concretions similar to the "loess-dolls" figured by Wright.

The occurrence of mammalian bones in the loess is paralleled by that of reptilian remains in the Cave Sandstone. All the forms hitherto discovered are light-limbed probably cursorial forms — *Gyposaurus*, *Thecodontosaurus* and the like, together with *Notochampsa*. As has been shown, this latter was erroneously supposed to be a Crocodile, but is in reality a light-limbed long-snouted armoured Pseudosuchian. There is nothing of the water-loving, marsh-living type in this assemblage; they are all very conceivably the inhabitants of an arid or semiarid clime, adapted for comparatively rapid transit from place to place. In no case has a complete skeleton been found; but, on the other hand, isolated bones are rare and the usual occurrence is in the form of articulated portions of a skeleton. It should be noted that, in the case of *Notochampsa*, the skeleton is nearly complete, even some of the fragile bones of the fingers and toes being preserved. Had the conditions been moist, it is improbable that such would have been preserved in a sandstone-water percolating through the porous sediment would have rapidly dissolved the bones which have been preserved, as we believe, by the rapid accumulation of a dry wind-borne coarse siliceous dust.

That the climate was not absolutely arid is shown by 1) the fact that the deposit is in no sense a "desert-sandstone" in the Cape — O. F. S. area, and 2) the very rare local developments of greenish and bluish shales containing a water-fauna. Of these, the best-known is the shale-band in the Cave Sandstone at Siberia in the

Wodehouse Division. Here is a 20 feet zone of finely-bedded blue and green shale containing abundant fossils among which have been recognised one imperfect fish, several examples of insects and numerous examples of a small Ostracod, a *Cyzicus* in various stages of growth, and of an *Apus*-like Phyllopod, *Lepidurus*. The crustacean part of this fauna is all of a semi-arid facies, capable of living in damp or even dry mud for many months of the year even as they or their near relations do in the Karroo to-day. Fish are also found in what is supposed to be Cave Sandstone near Ficksburg, O. F. S., from which place slabs have been quarried with numerous specimens of *Semionotus capensis* on each, the occurrence seeming to indicate, from the fish point of view, a sudden catastrophic dessication of their living quarters.

Further, the Rev. S. S. Dornan has recorded that many fossil fish occur in the Cave Sandstone at Masitisi, Basutoland, as well as silicified trunks of trees.

It is of interest here to consider a little more closely the physical conditions of deposition, other than climate, of the Cave Sandstone in the Cape-O. F. S. area.

Although in places there is a gradual transition from the Red Beds to the Cave Sandstone indicating absolute continuity of deposition from one to the other especially in the North, in other places there is undoubted unconformity so that, while in some parts of the area deposition was going on, in other parts erosion was being effected at a greater rate than deposition.

As an extreme instance of this we may cite the fact that at Glenelg in the Maclear District the Cave Sandstone rests directly on pebbly grits of the Molteno Beds — the Red Beds having entirely disappeared. Here it does not seem certain whether the Red Beds were eroded subsequent to the deposition of the main mass of the formation and before the deposition of the Cave Sandstone, by means of a strong scouring agency, or whether the absence of Red Beds is to be explained by a continuous "contemporaneous erosion".

We have already referred to the unconformity which occurs in the neighbourhood of the ancient volcano at Thule. At Tent Kop, in the Maclear district, a bed of volcanic ash rests on the Red Beds and underlies the Cave Sandstone; while other examples might be cited showing that volcanic activity began, at any rate in the South, *before* the deposition of the Cave Sandstone.

At Tent Kop the sandstone overlying the Ash bed is full of small angular inclusions of indurated sandstone and shale.

That volcanic activity was rife during the formation of the Cave

Sandstone is evidenced by many examples, especially in the south of the region and towards the top of the formation. In Maclear two beds of sandstone are intercalated in the lavas. It is interesting, too, to note that the ash here contains fragments of Molteno Sandstone up to 5 feet across, and a few blocks of pre-Karroo quartzite. These have evidently been torn off from below and thrown out by volcanoes in the neighbourhood.

Further north, in Barkly East and the neighbouring districts, in a few places the Cave Sandstone is entirely absent, the volcanic flows resting directly on the Red Beds. In the Barkly East Division the formation is split up by numerous beds of lava and ash, both of which are sharply defined from the sandstone. At Siberia in Wodehouse, three bands of sandstone are intercalated in the lavas. At the head of Bamboes Spruit in Herschel there are four such bands. Near the large Belmore volcano in Barkly East the Cave Sandstone contains numerous masses of vesicular lava up to four feet across, the lower surfaces of which consist of pipe amygdaloid. Du Toit has described a section near Barkly East Township showing pinkish sandstone resting on a bed of ash and abutting at one end against a sheet of doleritic lava; in the sandstone are embedded rounded masses of altered doleritic lava. At Waterfall in the Barkly Division there is a section showing alternation of volcanic and sedimentary material, both the sandstones and the lavas having a lenticular character; there are pipe-amygdaloids at the base of some of the lava-flows and rounded portions of lava in the beds of sandstone.

It is important to notice that in all the occurrences cited in the last paragraph the intercalation of sandstone and volcanics occurs above the main mass of the Cave Sandstone; also that the sandstone in this upper portion of the formation is usually well laminated. This fact, coupled with the occurrence of pipe amygdales in the lavas where these rest on the sandstone, seems to show that the conditions of deposition of the sandstone were somewhat different from those of the main mass and were somewhat moister and less arid. However that may be, it is apparent that the Cave Sandstone was not deposited uninterruptedly; in places the deposition was hindered by outbursts of ashes and of lavas from the many volcanoes of the area. Du Toit remarks "While the Cave Sandstone accumulated freely in the north and was followed by lava flows, the ejection of ash in the south was so considerable that full development of the sandstone was prevented in that region, and it was only at a slightly later period that lavas commenced to be erupted there".

The large Modderfontein volcano in Aliwal North came into existence

while the Cave Sandstone was being laid down, for in an outlier of Cave Sandstone near by the rock is full of small fragments of shale and sandstone that were blown out from the volcano.

Very little, or no, work has yet been done upon the area north of the Orange River, but it is probable that the Cave Sandstone there will be but little affected by volcanic flows — the volcanoes seemingly having come into being progressively from south to north in point of time.

The work of du Toit in the south and centre of the area has shown that, presumably in connection with the outbreak of volcanic activity, there was a certain amount of faulting and folding which has affected the sediments but not the overlying lava flows.

In Maclear, the dips of the Cave Sandstone show that folding took place during, and probably also somewhat previous to its deposition and that they had ceased by the time that the area became flooded with lavas. There are local disturbances of both the Red Beds and the Cave Sandstone, but the overlying lavas are undisturbed. A certain amount of subsidence caused the formation, too, of local hollows which were filled with ash.

At Siberia, in Wodehouse, faulting on a small scale affects the Red Beds and Cave Sandstone, but not the volcanics. In the Barkly East Division the main bed of Cave Sandstone and the ash-bed are affected by small folds, producing domes and basins in the strata, and — according to du Toit — there is clear evidence of a great zone of subsidence formed during the eruption of the earlier lavas. A generalised section along the Kraai River shows the Red Beds and the main-body of Cave Sandstone with the ash-bed bent into an asymmetrical undulating trough, while the lavas with the thin intercalated sandstone beds lie horizontally and undisturbed except in the east.

It is of interest briefly to consider the probable changes which took place during Stormberg times in the land area from which these sediments were derived.

That a land mass lay to the south and probably partly to the east of the present area occupied by the Stormberg beds cannot be doubted. How far to the south it lay we cannot say; but the occurrence of a fair thickness of Molteno Beds near Port St. John's indicates the presence of a land-mass to the south of the present continent. Of its petrological characters little can be said. The constituent minerals of the Stormberg sandstones indicate derivation from granitic or granitoid rocks in part. The lithological character of the original rock from which sediments are derived is always, however, a matter

mainly of speculation unless the sediment is near the region of erosion and other conditions are favourable for preserving the mineral constituents of the original rock or rocks in an unaltered condition. Chief interest centres around the probable physiographic changes of the parent land-mass.

A general survey of the Stormberg sediments reveals a sudden interruption of deposit of shales and fine-grained sandstones which took place throughout Upper Beaufort times and the displacement of that type of sediment by a series of grits, coarse-grained sandstones, conglomerate bands, and somewhat irregular large lenses of shales (sometimes coaly). This type was followed by a series of sandstones, reddish in colour and becoming progressively finer-grained, interbedded with red clays; and that by the fine-grained Cave Sandstone. This succession can be profitably contrasted with that of the Siwaliks of the Himalayas as described by Medlicott and Blanford (1879). They say "Sandstone immensely preponderates in the sub-Himalayan deposits, and is of a very persistent type from end to end of the region and from top to bottom of the series. Its commonest form is . . . of a clear pepper and salt grey, sharp and fine in grain, generally soft, and in very massive beds. The whole Middle and Lower Siwaliks are formed of this rock, with occasional thick beds of red clay and very rare thin, discontinuous bands and nodules of earthy limestone, the sandstone itself being sometimes calcareous and thus cemented into hard nodular masses. In the Upper Siwaliks conglomerates prevail largely; they are often made up of the coarsest shingle, precisely like that in the beds of the great Himalayan torrents . . . The mountain torrents are now in many cases engaged in laying down great banks of shingle at the margin of the plains, just like the Siwalik conglomerates; and the thick sandstones and sandy clays of the Tertiary series are of just the same type of form and composition as the actual deposits of the great rivers." They conclude that the Siwaliks were laid down as a fluviatile outwash from the rising Himalayas.

We see here that the succession in the Siwaliks is the exact opposite of that shewn by the Stormberg Beds — at least to the top of the Red Beds. In the Siwaliks fine-grained sandstones and red clays give place to coarse-grained sandstones, conglomerates and coarse shingle-beds. If Medlicott and Blanford are correct in assigning the Siwaliks to fluviatile deposition from a rising mountain mass, then it may be presumed that the Stormberg Beds are possibly sediments derived from a land-mass slowly lessening in altitude.

This presumption is further buttressed by certain theoretical con-

siderations which have been fully set out by Barrell (1908) and which will be briefly noticed here.

In youthful topographic stages rock-breaking dominates over rock-decay; in topographic old age the reverse is normally true. In arid climates, however, and to a lesser extent in cold climates, where chemical action plays a less important part than in humid and wet climates, there is dominance of disintegration over decomposition even in topographic maturity or old age. Again, in the youthful stages of topography the waste is carried away from the higher ground as soon as disintegration frees it from the rocks, in arid and subarid climates by the streams arising from torrential rains, and is deposited in inland basins or on piedmont slopes. Under arid and subarid conditions this waste is coarser, less decomposed and has less true clay than similarly situated waste of more pluvial climes. Even in maturity, the mountains of arid regions retain their nakedness, roughness and sterility and give rise to disintegrated waste rather than decomposed material. As, however, the difference in altitude between the parent mass and the sediments formed from it diminishes, so will the transporting power of the torrents lessen, and the sediments will tend to become finer in grain — the larger fragments of disintegrated matter being unmoved by the slower and less powerful streams.

In the old age of arid regions wind erosion becomes increasingly more important than water erosion, so that the products of erosion in old-age, when the desert surface is approximately flat, are chiefly wind-borne loess and dune-sand.

A number of instances might be cited of present-day regions in which one or more of these stages is seen; it is enough to quote the Eastern Persian area described by Huntington, the aerial deltas arising from the decaying high-lands of Arizona, and the sand-filled valleys and "island mountains" of Namaqualand in South Africa. It would seem that the evidence afforded by the nature of the sediments, coupled with these theoretical considerations and present-day examples, tends to point to the conclusion that the land-mass from which the Stormberg sediments were derived, suddenly rejuvenated at the end of Beaufort times, was in process of planation during the deposition of the beds until the intense volcanic activity put an end to sedimention in the area.

On the other hand, there is little or no direct evidence of local or regional earth-movement such as would have caused sudden rejuvenation at the end of Beaufort times; and the sudden onset of the conglomeratic and coarse type of sedimentation which characterises the Molteno Beds may have been due to more intense precipitation

of moisture resulting in torrential downpours and a consequent rush of swollen streams at certain seasons. Even if that be a partial explanation of the phenomenon, it is certain that the land to the south must have had a marked elevation above that upon which the sediments were deposited. No intensity of rain-fall would cause pebbles and coarse sand to be washed from one area on to another at approximately the same level; in other words, subaerial conglomerates are not features of wellmatured or senescent stream-deposits.

Transvaal Area.

The correlation of the various outliers of the Bushveld Sandstone with one another and with the Stormberg Series of the Cape has been based mainly upon petrological grounds and upon the fact that they underlie the amygdaloidal lavas. It has been supposed that they are but remnants of a once extensive mass; but, however that may be, it is certain that they were laid down upon an uneven surface.

In the Springbok Flats area, north of Pretoria, the series is bent into a double basin, and rests either directly on the Red Granite or upon highly inclined and sometimes much broken and faulted sediments of the Waterberg System. The basal beds of the Bushveld Series here are frequently composed of debris and fragments of granite, felspar, and quartz with interstitial partly decomposed felspathic material — derived from the Granite — and occasionally of large rounded quartzite pebbles, probably from the Waterberg Conglomerate. These coarse beds are confined to the edge of the Series. Above them are in general, layers of red marl or shale; and they are followed by the true Bushveld sandstone. In the west and south of the area. however, the red marl overlies the so-called "Coal-Measure Grits".

In the Komati Poort area the beds dip to the east, sometimes at an angle of 10 degrees; and this dip has been held to account for the occurrence of the series at a level so much below that of the Springbok Flats. Here the "Bushveld Sandstone" lies, apparently conformably, upon the "Coal Measure Series" — which lie themselves upon the older Granites, schists, and altered sediments of the Swaziland System in the following order: — Pale, hard, often coarse felspathic grits, often massive with pebbly bands, at the base, followed by sandy micaceous shales, carbonaceous shales, grits and sandstones. Between these latter and the fine-grained sandstone yellow shales occur at one or two points. The upper portion of the Coal-Measure Series carries *Glossopteris.*

Garrard has traced this series in a north-south belt through eastern

Swaziland to within 25 miles or so of the Zululand coal-field. In the latter (St. Lucia field) the coal-bearing beds are separated from the Basalts by horizontal beds of calcareous sandstone. At Somkele the coal is considered by du Toit to be of Beaufort age, overlain by red and purple shales which he thinks are Middle or Upper Beaufort.

In the N. W. Zoutpansberg the Bushveld Sandstone rests either on the old gneisses and schists or upon a variable thickness of Coal Measures underlain in places by Glacial Conglomerate.

The palaeontological evidence seems to bear out the correlation of the Zoutpansberg and Springbok Flats members with the Red Beds and Cave Sandstone of the Cape Province area. Two questions remain to be settled definitaly — 1. Is the fine-grained sandstone of the Komati Poort area really Bushveld Sandstone? 2. Is there any Transvaal representative of the Molteno Beds? Kynaston has already covered most of the ground, but the questions can be briefly discussed.

1. The only recorded fossil from the Komati Poort area is *Glossopteris* sp. from below the fine-grained sandstone. Here, in the southern extension of the belt in Swaziland, and in Zululand upper coal-seams occur near the top of the "Coal-Measures". In the St. Lucia coal-field the following plants have been found: — *Glossopteris browniana* var. *indica*, *G. browniana* var. *angustifolia*, *G. damudica*, ***G. retifera***, *G. acuta*. *G. spatulo-cordata*, *Phyllotheca* sp. and *Taeniopteris spathulatum*. This flora was held to be an Ecca one by Etheridge jun.; but there seems little doubt that the assemblage is, as a whole, typically Lower Beaufort. These beds are, however, separated by a wide belt from the amygdaloidal lavas at Somkele, a belt which is not yet at all known. If the coal-bearing beds at Komati Poort are the equivalent of those at St. Lucia then two possibilities arise: — (a) that the fine-grained sandstone at Komati Poort is true Bushveld Sandstone and lies unconformably on the Beaufort Beds — just as the Red Beds lie unconformably on the Beaufort Beds in the N. E. Free State; or (b) that the fine-grained sandstone is itself of Upper Beaufort age. The general nature of the sandstone, its mode of weathering, its non-variability over a large district, and the known unconformity at Harrismith and in the neighbourhood lend strong support to the former alternative. The matter awaits further treatment based upon more detailed field work; but it is important to note that the similarity of the sandstones in the different areas points to formation under similar climatic conditions; and these conditions do not seem to have occurred in the southern area until the onset of Red Beds times.

2. This question has been partly answered above. In the Cape the Molteno Beds are a local phase corresponding to a certain type of climate and certain geographical conditions which enabled coarse pebble-beds, finer sandstones, and carbonaceous shales to accumulate in a huge subaerial delta over a plain situated at the foot of an upraised land mass to the south. In the High Veld of the Transvaal there is no corresponding mass of sediment. During the deposition of the Beaufort Beds in the south of the Union, the Transvaal area was subjected to erosion and denudation (deposition only taking place within certain basins), the sagging of the geosyncline in the south possibly being compensated by a rising of the northern area. This period of erosion, however, came to an end at some point during Stormberg times; and in some of the basins formed on the unequal land surface debris accumulated, to be soon covered by thin shales and the Bushveld sandstone. There is evidence to show that warping and sagging took place in the region north of Pretoria during Karroo and post-Karroo times, which would account for the overlaps round the margins of such basins as have been preserved. The basins, in fact, owe their preservation to the sagging which took place. In spite of minor differences visible in specimens from different places the Bushveld Sandstone is of so uniform a character that it is reasonable to suppose that the patches that remain are but relics of a once more widely-spread layer that stretched up into Southern Rhodesia. Like the Cave Sandstone it was subaerial and probably mainly aeolian; and once the basins were filled up by the driven and blown sand, the material spread out to cover a larger and larger surface. We cannot estimate its maximum extent, nor conjecture what peaks of older rock stood up above the sandy levels. We shall note later that there seems to be a lateral change from a fine-grained "loess-like" deposit to a somewhat coarser, rounded desert-sandstone. In this area the basal conglomerates may be the equivalent of the Molteno Beds — they are equally the result of the action of torrential rains able to produce temporarily streams strong enough to carry fair-sized pebbles; while in the basal part of the reddish clays north-west of Pienaars River Station the occurrence of a very thick compound seam of coal lends colour to this suggestion.

The climatic conditions which gave rise to the Red Beds of the Cape were shortlived in the Transvaal; and the climate rapidly changed to one comparable with that reigning in Cave Sandstone times further south; the onset of such conditions was possibly earlier in the north than in the south. As a general conclusion, the further north one goes from the Cape area the greater is the evi-

dence of aridity furnished by the Bushveld and Forest Sandstones; and it is of interest here to examine the .evidence afforded by a microscopic examination of the rocks from the various localities.

The closest approximation to the true Cave Sandstone is possibly afforded by the fine-grained sandstone from Komatipoort. This was described by Kynaston as follows:— The rock "shows numerous small quartz grains, of a generally uniform size, and on the whole angular and sub-angular rather than rounded, embedded in an exceedingly fine-grained matrix, in which individual grains are barely distinguishable. Grains of plagioclase felspar may occasionally be noted..... The microscopic characters agree very closely with those of the fine sandstones from the Springbok Flats, the proportion of matrix to individual quartz grains being somewhat higher in the latter."

The Buiskop sandstone is of fairly fine grain, and there are very few grains which are coarser than the general texture of the rock. A considerable amount of ferruginous cementing material is present in the red varieties; and the grains of quartz, although not splintery, are polygonal in outline with rounded corners. The red variety is very similar to the sandstones of the Red Beds.

A specimen of sandstone from Nelson's Kop, in the west of the Waterberg District near the Limpopo and Pongola Rivers, contains two types of quartz grains — a larger and a smaller. The larger grains are less prevalent than the other; they are rounded without any trace of angularity and they vary in size from a grain having diameters of 0·3 mm. and 0·22 mm. to one with diameters of 0·6 mm. and 0·4 mm. The smaller grains, of a diameter of 0·15 mm. and under, are not so obviously rounded, but none of them are splintery, although thin sections are somewat polygonal. Most of the grains are coated with a thin reddish-brown layer of iron oxide, while there are scattered grains of the same material. Felspar is much less common than in the Forest Sandstone. The whole section is reminiscent of that figured by Molyneux as a typical section of the Nyamandhlovu Sandstone. For the sample I am indebted to Dr. du Toit, who also supplied me with a piece of Bushveld Sandstone from Castle Kopjes, on the main road from Louis Trichardt to Messina.

The Castle Kopjes rock is light in colour and consists of equidimensional grains of quartz with a very occasional grain of plagioclase. The grains are fairly well rounded, smaller than those of the Nelson's Kop stone and similar in size to those of Buiskop.

Reviewing the features of these Transvaal specimens, it would

appear that, in general, they are intermediate between the true Cave Sandstone of the South and the Forest Sandstone and Nyamandhlovu Sandstone of Rhodesia — the more southerly outcrops partaking more of the nature of the former, the westerly and northerly ones more of the character of the Rhodesian rocks. Thus we can picture the loess-like formation of the south giving place gradually to the true desert sands of the north, the fragments of the Transvaal deposits which now remain to us representing the transition stage between the two types and shewing an intermingling of the fine-grained angular fragments from the south with the rounded desert sands of the north.

Age of the Stormberg Series.

Until fairly recently the age of the Stormberg Series was accepted as ranging from Rhaetic to Lower Jurassic; within the last few years, however, there has been a tendency to throw back the age along the time-scale and to consider the Cave Sandstone as no later than Rhaetic.

The evidence in favour of the older view was mainly two-fold, based on the nature of the plants of the Molteno Beds and that of ***Notochampsa*** from the Cave Sandstone. The latter was thought by Broom to be a true crocodile allied to ***Pelagosaurus***; and as crocodiles did not appear until the Jurassic in other parts of the world the Cave Sandstone was deemed Jurassic. The Molteno plants were considered by Seward to be of Rhaetic age; and the Series was thus spaced between those limits.

Detailed examination of the evidence leads, however, rather to the acceptance of the later view. In the first place the Rhaetic age assigned to the Molteno plant forms is based upon what is by no means clear evidence and in view of recent discoveries the conclusion may need considerable revision. Dr. du Toit is studying a large amount of material mainly collected by himself, and although his results are not ready for publication he has permitted me to say that the undoubted association of *Glossopteris*, *Chiropteris*, ***Pterophyllum***, *Callipteridium* and apparently *Rhexoxylon* with the typical Molteno genera *Baiera*, ***Thinnfeldia***, and ***Taeniopteris*** give a very pronounced Keuper appearance to the flora.

The vertebrates which it should be remembered come from still higher horizons, when studied in detail, also bear a Triassic aspect.

The three Cynodont forms are specialised relics from the Upper Beaufort Beds. These latter, which underlie the Molteno Beds, have

yielded the Stereospondyls *Capitosaurus* and *Trematosaurus*, forms which are found in the Bunter (L. Triassic) of Germany.

Among the Archosauria the crucial *Notochampsa istedana* has been shown to be not crocodilian but a Thecodont lying apparently between *Aetosaurus* and the Crocodilia. The former occurs in the Keuper of Germany, the latter first appear in the Lower Jurassic; this would denote a Rhaetic age for the Cave Sandstone which has yielded the intermediate form.

Erythrochampsa from the Red Beds has a crocodilian pelvis; but too little is known of the form to be certain of its affinities, and it has thus no bearing on the discussion. *Sphenosuchus* from the Red Beds is a Pseudosuchian of somewhat specialised form. It is probably somewhat later than *Aetosaurus* (Keuper), although it should be noted that the highly specialised *Schleromochlus* is found in the Lettenkohle (Upper Muschelkalk) of Scotland.

In Europe, *Thecodontosaurus* ranges from the Lower Muschelkalk to the Middle Keuper: the larger *Gresslyosaurus* and *Plateosaurus* occur in the Upper Keuper and Rhaetic. In South Africa the order of appearance is reversed. The larger *Euskelesaurus* and *Plateosaurus* are lower Red Bed forms while the lighter-limbed *Thecodontosaurus*, *Massospondylus*, *Gyposaurus* and the like occur in the Upper Red Beds and Cave Sandstone. *Massospondylus* has been shown to have retained a primitive form of shoulder-girdle; and it seems probable that these light-limbed animals migrated to the Stormberg region only when conditions became sufficiently arid for them in the south. In spite of the slight differences between the detailed succession of the Saurischia in the European and South African regions there is no doubt as to the general similarity of the fauna; and since none of the European genera survived beyond the Rhaetic additional weight is lent to the theory that the Stormberg Series is not later than Rhaetic.

The occurrence of *Geranosaurus* is paralleled by that of the Predentate *Nanosaurus* in the Rhaetic of North America; while the Cave Sandstone fish *Semionotus* occurs in the Keuper of Europe.

Finally, the general aridity which, as we have seen, prevailed increasingly through Stormberg times is a characteristic of the Triassic epoch; and in the absence of any evidence to support the theory of the Jurassic age of part of the Series we must conclude that Stormberg sedimentation began in Middle Triassic time and ended in the Rhaetic.

Professor Schwarz considers that the Stormberg Beds should be divorced entirely from the Karroo System and that, if they are not

sufficiently important to warrant their promotion to a system of their own, they should be grouped with the Uitenhage System. His reasons for this view, as stated in Proc. Geol. Soc. S. Africa 1919, are open to question. "The most important of all faunal changes, the passage of the vertebrate remains from reptilian to mammalian" is not yet proved to be a feature of the Stormberg Beds; the fauna is a reptilian one, with members of the Beaufort Theriodontia still living; the Dinosaurs are, as we have seen, Triassic and not Jurassic nor Cretaceous forms; and *Glossopteris* is still a feature of the Molteno Beds.

Important evidence bearing on the age of the sediments has recently been forthcoming from South America. The beds of Karroo age in the State of Parana, Brazil, show the following succession: —

6.	Eruptivas da Serra Geral		600	metres.
5.	Arenito de Botucati		200	,,
4.	Serie Rio Rasto		100	,,
3.	Serie Passa Dois	Calcareo Rocinha	3	,,
		Grupo Estrada Nova	150	,,
		Grupo Iraty	70	,,
2.	Serie Tubarao		180	,,
1.	Serie Itarare		350	,,

The Itarare Series is glacial, and its upper portion contains a marine fauna of Lamellibranchs and Gasteropods.

The Tubarao Series contains a *Glossopteris* flora.

The Iraty Group contains the reptiles *Mesosaurus* and *Stereosternum*.

The Rio Rasto group has yielded the reptiles *Scaphonyx fischeri* and *Erythrosuchus* sp. and is presumably approximately equivalent to our Upper Beaufort Beds. Recently Holdhaus (1918) has described from the same Series the lamellibranchs *Solenomorpha similis*, *S. intermedia*, *S. altissima*, *S. deflexa*, and *Sanguinolites elongatus* — an assemblage which has led him to class the beds definitely as Permian.

The Botucati sandstone, sandwiched as it is between the beds containing *Erythrosuchus* and the thick volcanic outpourings which, like those of the Stormberg, made an end of sedimentation, can but correspond to the Stormberg sediments of South Africa. Following as it does conformably upon strata now classed as Permian there can be little doubt that it is not later than Triassic in age — a result in accordance with that now obtained from our consideration of the South African deposits.

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12. — *On some Gorgonopsian skulls in the collection of the South African Museum.* — By S. H. Haughton B. A., D. Sc., F. G. S., Hon. Curator of the Palaeontological Collections.

(With 8 Text-figures).

In a recently published paper ("The Bases of Classification of the Theriodontia", Proc. Zool. Soc. 1921, p. 35) Watson has described in some detail the Gorgonopsian and Therocephalian types in the possession of the British Museum which are sufficiently well preserved to show those features of the skull which have an important bearing on the interrelationships of the Therapsid Reptiles; and has, at the same time, drawn attention to the fact that a number of the types belonging to other Museums are somewhat imperfectly known. The following notes are based upon a study of Gorgonopsid skulls which are in the collection of the South African Museum, and are mainly observations additional to those which occur in the original descriptions of the various specimens.

The forms discussed are:

1. *Galesuchus gracilis* Htn. — *Tapinocephalus* zone.
2. *Scylacops capensis* Br. — Lower half of *Cistecephalus* zone.
3. *Aelurognathus tigriceps* (Br. & Htn.) — Lower half of *Cistecephalus* zone.
4. *Aelurognathus serratidens* (Htn.) — Lower half of *Cistecephalus* zone.
5. *Gorgonognathus longifrons* Htn. — Lower half of *Cistecephalus* zone.
6. ***Arctognathus whaitsi*** Htn. — Middle of *Cistecephalus* zone.
7. *Sycosaurus laticeps* Htn. — Middle of *Cistecephalus* zone.
8. An unnamed form. — Middle probably of *Cistecephalus* zone.

Galesuchus gracilis, Htn.

1915. Haughton. Ann. S. Afric. Mus. XII, 3, p. 82. Fig. 10.

This form is of great interest as being the earliest known Gorgonopsid. The type and only specimen came from the lower part of the Tapinocephalus zone; and it is unfortunate that the specimen is not more perfect. The snout is missing; the zygomatic arches are almost weathered away; and the natrix is so intractable that it has not yet been possible fully to develop the palate and basi-

cranial region. Nevertheless, certain observations can be made beyond those published in the original description.

As a whole, the skull is narrow and elongate, the orbits looking outwards and the temporal fossae more outwards than upwards. It is probable that the squamosal region was not very much broadened. The snout is high, almost as high as broad in the canine

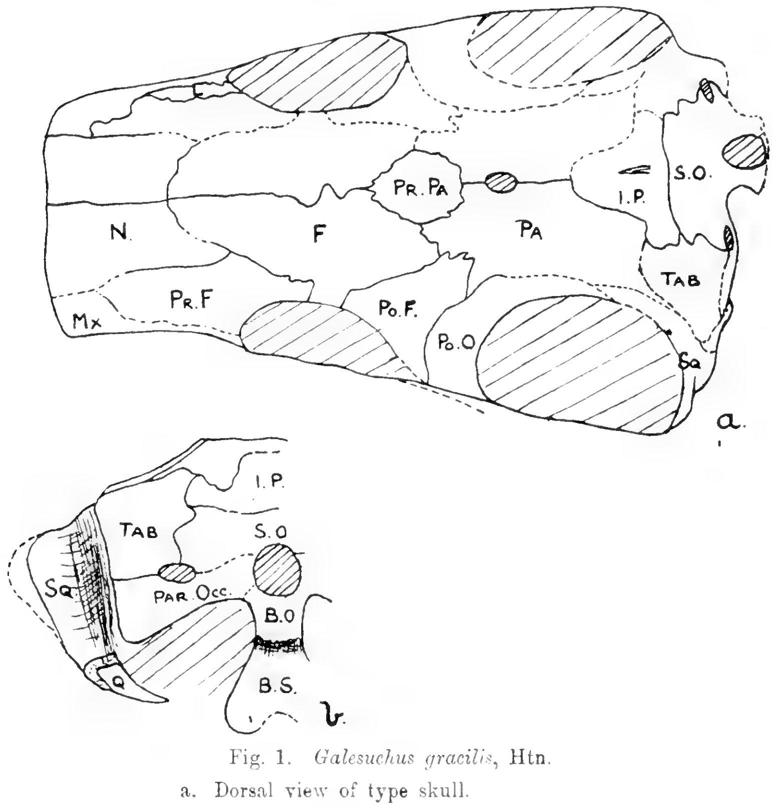

Fig. 1. *Galesuchus gracilis*, Htn.

a. Dorsal view of type skull.

b. Occipital view of left side of type skull.

region, and is square in cross-section. The occiput is very sloping — the slope is probably not very much exaggerated by post-mortem deformation.

The dorsal and lateral surfaces of the skull have already been described, and can be readily understood from the restored figures given. Interesting features are the great depth of the infraorbital bar, which is almost wholly formed of the jugal: the greater anterior extension of the prefrontal over the lachrymal, which is as deep as

long; and the small part which the frontal plays in the orbital border, considerably less than in *Gorgonops*. The postfrontal is of the shape seen in *Scymnognathus whaitsi*. There is no depression on the preorbital surface.

The parietals are excluded from the border of the post-temporal fossa, but each sends a narrow process backwards to lie between the squamosal and tabulare.

The squamosal is partly lost, but it can be seen that its posterior surface, at the articulation with the tabulare and paroccipital process, is produced backwards to form a ridge — the inner wall of the auditory groove — as in *Arctops*; and that on the outer side of this ridge there is a shallow vertical groove.

The basicranium is very deep. The condyle is weathered away; but the basisphenoid tubera, which are close together, lie directly below the occipital condyle. The median basisphenoidal keel is thin and deep, lessening in depth anteriorly as it nears the level of the pterygoid flanges. These lie below the postorbital bar.

Very few features of the brain-case can be determined. The brain-cavity is small and shallow, the foramen magnum being high up in the skull. The fenestra ovalis is large and low down. The epipterygoid is a slender rod expanded dorsally; its lower end is not seen.

As far as its features are discernible, therefore, the form shows a mixture of primitive and more advanced characters — some of the latter being sufficiently pronounced to prevent us from considering *Galesuchus* as ancestral to the forms of the succeeding zone such as *Gorgonops* or *Arctops*. The primitive features are (1) the high, square section of the snout, (2) the laterally directed orbits, (3) the posterior position of the pterygoid flanges, (4) the sloping occiput, (5) the deep basioccipital and (6) the deep basisphenoidal tubera. More advanced features are the lack of antorbital depression, the reduction in size of the lachrymal, and the small part played by the frontals in the formation of the supraorbital border.

Scylacops capensis, Br.

1913. Broom. Ann. S. Afric. Mus. XII. 1, p. 8.

In the type specimen described by Broom the basicranial region of the skull is somewhat crushed; but in a skull obtained at Wellwood, Graaff Reinet by the Rev. J. H. Whaits (S. A. Mus. Cat. No. 3444) most of the details of this region are perfectly displayed. The skull in question differs from the type in being somewhat smaller, in having a slightly shorter snout and somewhat narrower

parietal region; but there can, I think, be no doubt that it is specifically identical.

The foramen magnum is small, and placed about onethird of the height of the skull above the base as seen in occipital view.

The basioccipital condyle is fairly large and rounded, although it is smaller than that figured by Watson in *Scymnognathus whaitsi.* The basioccipital is fairly thin posteriorly, but it swells out laterally in front to form part of the wall of the fenestra ovalis. Medially on the lower surface it is deeply and narrowly grooved — the groove being a continuation of that in the basisphenoid. The bone supports the exoccipitals above and the paroccipitals laterally. The exoccipitals are small, forming the lateral margins of the foramen magnum.

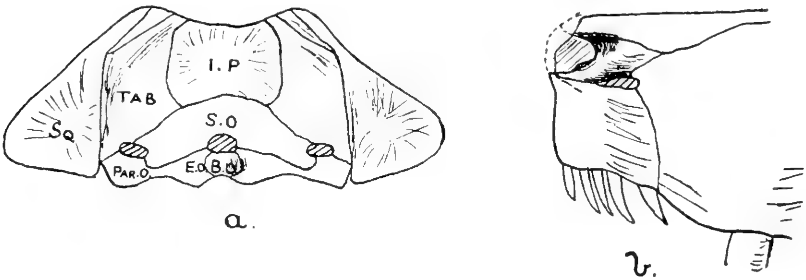

Fig. 2. *Scylacops capensis*, Br.
a. Occiput of type skull.
b. Left side of snout of type skull.

The occipital plate is very concave, so that the outer ends of the stout paroccipitals lie some distance behind the foramen magnum. The inner anterior end of the bone lies below the level of the basioccipital condyle, and forms part of the border of the fenestra ovalis. The type skull shows the presence of large tabular bones on the occipital plate.

The foramen jugulare has its lower end slightly below the top of the basioccipital condyle, and looks partly backwards and partly downwards.

The basisphenoidal tubera form the anterior border of the fenestra ovales and are placed well forward. Between them the basisphenoid is deeply hollowed; the ridges from them rapidly converge and combine to form the median basisphenoid keel which passes forward to meet the pterygoid.

In the type skull the septomaxilla rests on the premaxilla but has a short articulation with the maxilla posterior to the septomaxillary

foramen. The nasals end anteriorly in a nearly straight margin, and externally overhang the nostril slightly. The nostrils look mainly forward.

Careful development of the palate shows that Broom's figure is substantially correct. The pterygoid has no anterior prolongation and is widely separated from the posterior nares and prevomer by the palatine. The deep median groove in front of the pterygoids is partly covered in by processes of the palatines as in the Aelurosaurid figured by Watson in his 1921 paper; and there seems to be a median suture throughout this groove, the "vomer" thus being prevented from forming a part of the palatal surface.

AELUROGNATHUS TIGRICEPS, Br. and Htn.

1913. *Scymnognathus tigriceps* Broom and Haughton, Ann. S. Afric. Mus. XII, 1. p. 26, Pl. VI, figs. 1—4.

1913. *Scymnognathus tigriceps* Broom. Proc. Zool. Soc. p. 225.

1914. *Scymnognathus tigriceps* Broom Phil. Trans. B. Vol. 206, p. 46. Pl. VI, fig. 66.

The type skull is considerably crushed laterally, as is evidenced by the bending backward of the right pterygoid flange: so that probably the height of the snout is exaggerated when compared with its width. Comparison of the photographs of the type in the Annals S. A. Museum with Broom's figure of 1913 shows that the verticality of the snout in the latter is somewhat exaggerated. The snout is, however, not so rounded as that of *Scymnognathus whaitsi*. There is no "step" between the lower edges of the premaxilla and maxilla. The septomaxillary foramen is fairly large. The septomaxilla is large and has a large facial portion. The nostril is well overhung by the nasals, which have a straight front edge transverse to the axis of the snout.

The palate is so crushed that it is rather indefinite. The palatines are very large and the pterygoids comparatively small, the latter having no anterior extension to the internal nares. The presence or absence of a median bone on the palate is uncertain. The median portion of the palate is deeply grooved between two prominent ridges formed by the pterygoids and palatines. Between the pterygoid flanges and the posterior nares the palate is shorter than in *Scymnognathus whaitsi* approximating more in this particular to that of the Aelurosaurids. The ectopterygoid is large, and forms part of the front face of the powerful pterygoid flange. The anterior part of the mouth is considerably vaulted.

There is a weak preorbital depression on the face.

AELUROGNATHUS SERRATIDENS, Htn.

1915. *Scymnognathus serratidens* Haughton. Ann. S. Afric. Mus. XII, 3, p. 88. Pl. XIII, figs. 2—4. Text fig. 11.

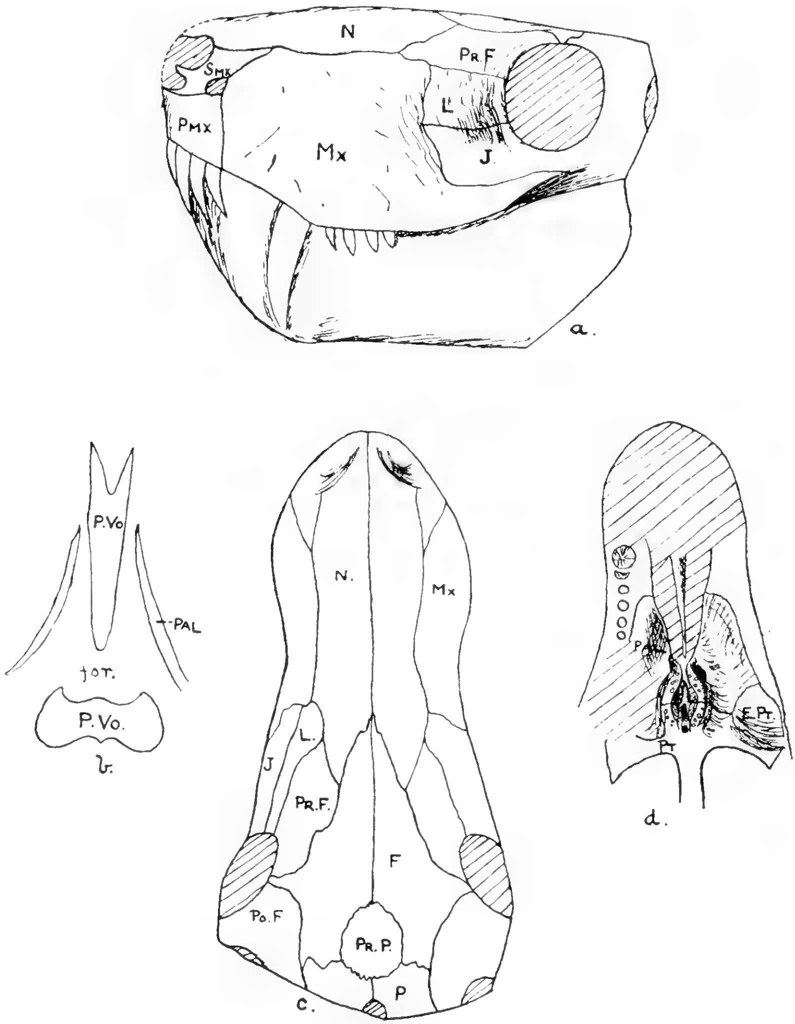

Fig. 3. *Aelurognathus serratidens*, Htn.

a. Left side of type skull.
b. Cross-section of snout just in front of canine, showing form of prevomers.
c. Dorsal view of type skull.
d. Palatal view of type skull.

Since the publication of the original description of this species the palate of the type has been almost fully cleaned; and its features are such that it has been thought advisable to separate this and the preceding form from the very different *Scymnognathus whaitsi* and to erect the new genus *Aelurognathus* for their reception. It is possible that this genus may also include other forms from the *Cistecephalus* zone, such as *minor* and *angusticeps*, which have hitherto been assigned to the *Endothiodon* zone genus *Scymnognathus*.

The median portion of the palate is excavated into a very narrow and deep groove bordered by strong tooth-bearing ridges formed by the palatines and pterygoids. The median groove is seemingly pierced by an interpterygoid foramen. The pterygoid has a short anterior prolongation on the roof of this vaulted area, but there is no median vomer seen on the palate. The posterior nares extend far back — to the level of the last molar. The interchoanal bar is ridged on its ventral surface. Superiorly it forms a thin median plate with a grooved dorsal edge; this plate is pierced posteriorly by a large transverse foramen. The relations of the prevomer, pterygoid and palatine in their vertical portions seem to be as in the skull which is later to be described as *Arctognathus whaitsi*.

The sphenethmoid meets the frontals and parietals and ventrally touches the median plate formed by the pterygoids and basisphenoid.

The ventral surface of the palate is essentially similar to that of the Aelurosaurid figured by Watson. The pterygoid flange is very massive; and as in *Aelurosaurus* the ectopterygoid forms the lateral portion of its front face.

The snout is deep and of rounded section, higher than broad. There is no "step" in the maxillary border. The septomaxilla has a large facial portion with strong turbinal processes; the septomaxillary foramen is fairly large. The anterior end of the nasal slightly overhangs the nostril. There is a pronounced antorbital depression, more pronounced than in *A. tigriceps*.

GORGONOGNATHUS LONGIFRONS, Htn.

1915. Haughton. Ann. S. Afric. Mus. XII, 3. p. 84. Pl. XIII, figs. 1—3.

1918. Haughton. Ann. S. Afric. Mus. XII, 6. p. 209. figs. 56, 57.

1921. Watson. *Gorgonognathus.* Proc. Zool. Soc. p. 78.

The type specimen has been split longitudinally in the posterior half, and shows the general shape of the brain-case, although it is not possible to remove the matrix and expose the foramina for the

exit of the nerves. The basioccipital is somewhat thicker than in *Scymnognathus whaitsi* and the floor of the cerebellum rises more abruptly. The pro-otic has a long upper process which appears to form a transverse plate forming the anterior wall of the cerebellum. Superiorly on the side-wall of the brain-case, the pro-otic articulates with what seems to be a distinct epiotic. Just below its upper sur-

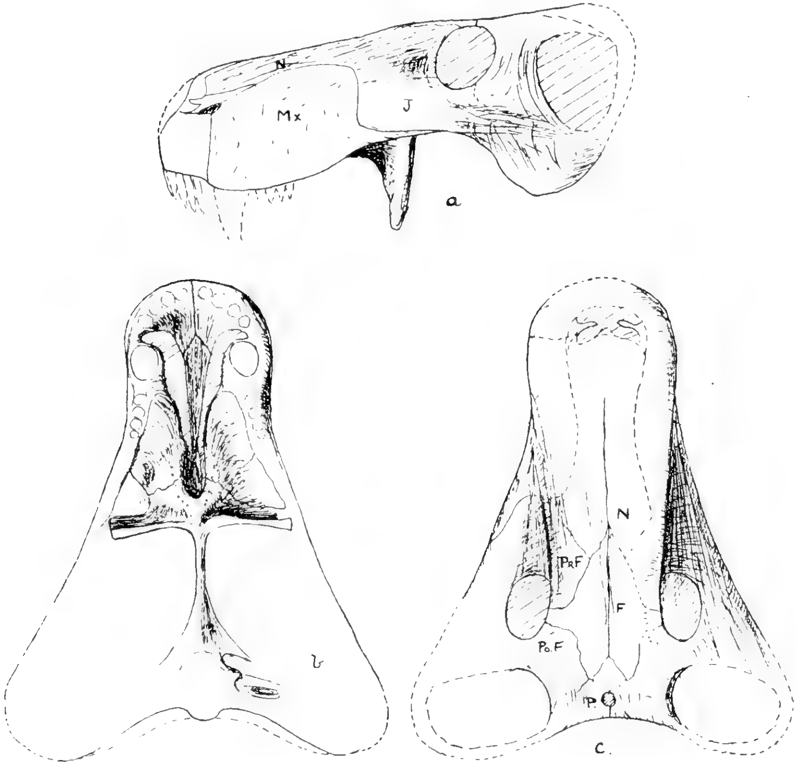

Fig. 4. *Gorgonognathus longifrons*, Hgn.
a. Lateral view of type skull.
b. Palatal view of type skull.
c. Dorsal view of type skull.

face the pro-otic is pierced by a large oval foramen whose longer axis lies vertically.

The median part of the palate is deeply vaulted. The ridges forming the boundaries of this vaulted area converge posteriorly, and are the inner edges of swollen portions of the pterygoids and palatines, which carry a few teeth. Lateral to these swellings the palate

is again vaulted, more broadly than and as deeply as the median excavation. The pterygoids do not reach forward to the internarial bar, although they have a slight anterior prolongation on the roof of the median vault. I am again unable to distinguish a median vomer on the palate. It is true that no median suture is to be seen; but the structure of the median plate, as revealed in an oblique section, seems to preclude the possibility of the median vomer appearing on the palate. The pterygoids seem to be fused. The pterygoid flanges are far forward. The palatines are large bones.

As Watson has pointed out, the dorsal surface of the skull is very like that of *Rhopalodon.* The snout is shorter, but the orbits occupy the same caudal position. The frontal forms part of the orbital border. There is a strong rounded ridge running forward from the supraorbital border, giving the prefrontal portion of the snout a squarish form. The front of the snout is rounded in section.

The "step" in the dentigerous border is weak; but the palatal portion of the premaxilla is considerably higher than the palatal portion of the maxilla, which has a deep vertical portion forming the outer wall of the internal nares.

Arctognathus whaitsi, n. sp.

The South African Museum possesses a skull collected by the Rev. J. H. Whaits at Houd Constant, Graaff Reinet, C. P. (S. A. Mus. Cat. No. 4337) which is considered to be an Arctognathid. The skull is of medium size and is typically a Gorgonopsian in the features of the lower jaw and intertemporal region. The upper surface is weathered away, so that the limits of the dorsal bones are not discernable. The dental formula of the upper jaw is probably i 4 c 1 m 4. The front of the snout is weathered away, and only 3 incisors are preserved; but there is sufficient space between the front incisors to permit of the presence in the whole skull of another tooth on each side. In dental formula, therefore, the skull agrees with that of the genus to which it is here assigned. The upper canine on the right side is a replacing tooth, the previous tooth being in a process of absorption. The molars are very small. All the teeth are finely serrated on the posterior border.

The chief measurements of the type are as follows: —

Greatest length	circa 170	mm.
Greatest width	,, 90	,,
Length from snout to front of orbit .	,, 97	..

Interorbital width	circa	42	mm.
Intertemporal width	,,	24	,,
Basal length	,,	165	,,

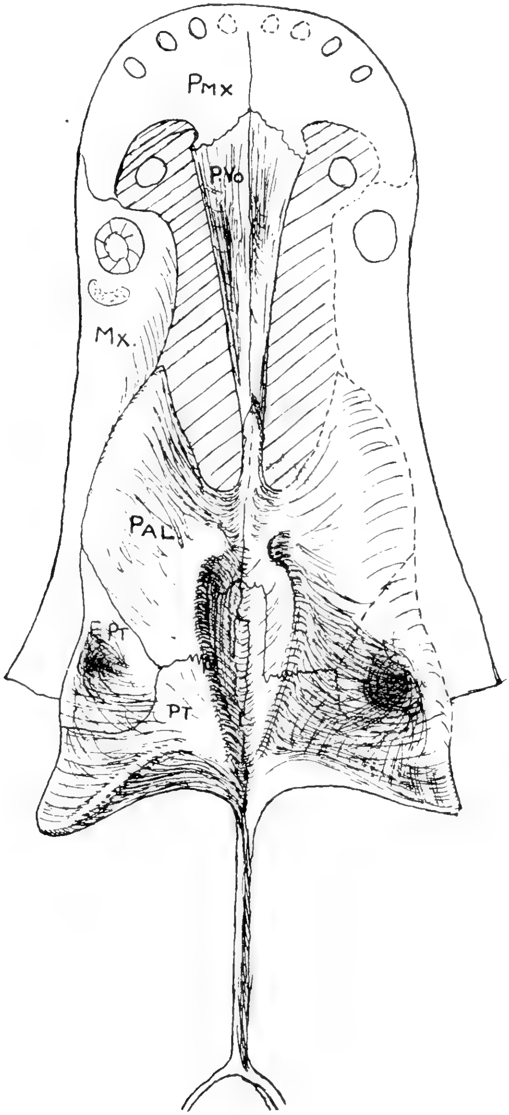

Fig. 5. *Arctognathus whaitsi*, Htn.
Palatal view of type skull.

The snout is as high as broad, and rounded in section. The nostrils are almost terminal and as far as can be seen, were not overhung to any extent by the somewhat straight front of the nasals.

The chief features of the palate can best be understood by reference to the figure reproduced herewith. The central vault is somewhat narrow and cordate, the ridges which bound it being formed partly of pterygoids and partly of palatines. The lateral vaultung is very pronounced, the highest portion of the vaults being at about the middle of the ectopterygoids. The interchoanal bar is mainly formed of the prevomers, the suture between which is plainly seen; but the posterior narrow part of the bar has its under surface formed by the palatines. These are large wing-shaped bones. The pterygoids form most of the roof of the median vaulted area, but are widely separated from the prevomers. In the figure given there seems at first sight to be a small longitudinal median bone lying on the roof of the palate between the pterygoids — i. e., occupying the position assigned by Watson to the vomer in Therapsid skulls. But I am of the opinion that the line shown in the drawing as bounding the left of this area is not a suture but a crack. It is not continuous, whereas the other longitudinal line continues back to the very small interpterygoid vacuity. This latter line I interpret as the median suture between the two pterygoids, thus eliminating the presence of the vomer on the palate.

The ridges bounding the vaulted area carry no teeth.

The brain-case and occiput are not preserved, nor can the epipterygoid be seen.

SYCOSAURUS LATICEPS, gen. et sp. nov.

The beautiful skull which forms the type of this new genus and species was collected for the South African Museum by the Rev. J. H. Whaits on the farm Zuurplaats in the Division of Graaff Reinet, C. P. A number of interesting details are presented by it, both on the dorsal and ventral surfaces.

The front of the snout is weathered, but the five incisors are shown. They are large teeth, oval in cross-section, with their pointed crowns serrated on the anterior edge. There is a diastema of 19 mm. between the 5th incisor and the large canine, which is closely followed by 5 small molars. Both canine and molars are oval in cross-section and the latter certainly are serrated on their anterior edges.

The anterior end of the nasal is missing and the details of the nostril are not decipherable. The septo-maxillary foramen is com-

paratively small. The dentigerous border of the upper jaw is incomplete; but it is possible that there was a slight "step" at the canine.

The nasals are long and narrow with no posterior widening. The lachrymal region is slightly depressed and somewhat overhung by a preorbital ridge. The intertemporal region is broader than the interorbital. The pineal foramen is small and surrounded by a

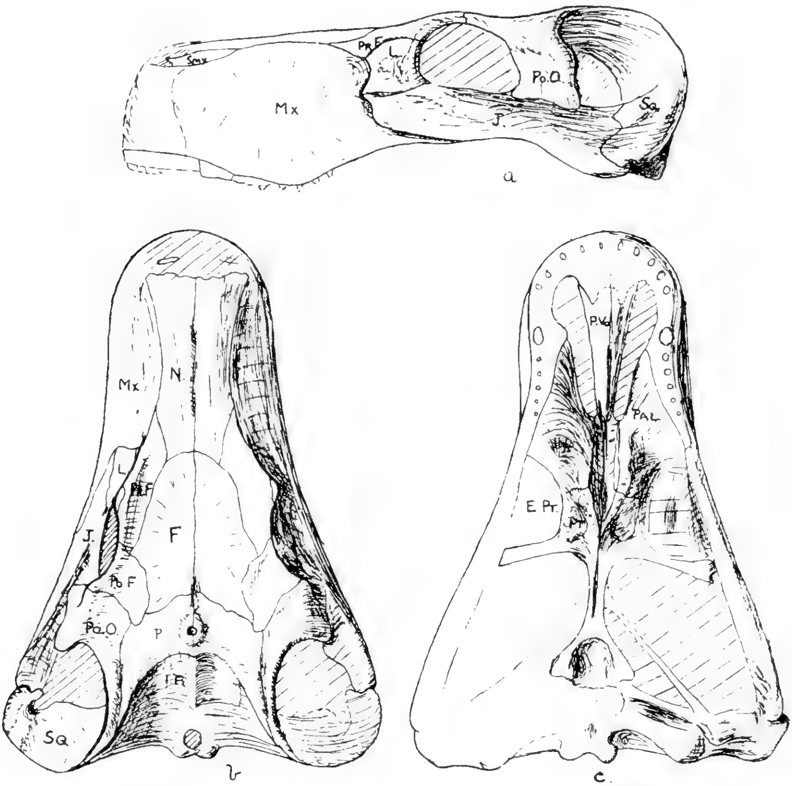

Fig. 6. *Sycosaurus laticeps*, Htn.
a. Lateral view of type skull.
b. Dorsal of view type skull.
c. Palatal view of type skull.

small raised boss. It lies at the level of the postorbital bar and just in front of the top of the occipital plate, which is shaped like a half-bowl. The frontal is comparatively small and wholly excluded from the orbital border by the postfrontal and prefrontal. The postfrontal is as in *Scylacops capensis*. There is no preparietal, and in

this feature the skull differs from all the Gorgonopsia in which the structure of the top of the head is known. The median suture extends the whole length of the top of the skull. About 13 mm. in front of the pineal foramen it is crossed by the suture separating the frontals from the parietals, the limits of which bone can be wholly seen. The parietal is wholly excluded from the border of the temporal opening by the large postorbital which meets the squamosal posteriorly. The temporal opening is bounded by the postorbital and squamosal except for its lower border, which is formed mainly by the jugal. The jugal is a large bone, supported by the maxilla in its anterior third, and overlapped by the postorbital halfway and the squamosal posteriorly. The jugal extends right to the end of the skull, almost touching the quadrate mass.

The palate is partially displayed. There is possibly a small, narrow, elongate interpterygoid vacuity lying just behind the descending flanges of the pterygoids. Immediately anterior to these flanges there is a fairly shallow median groove which passes forward to the bar separating the internal narial openings. In its posterior half this groove is narrow and its sides are formed of dentigerous keels of the pterygoids. At the bottom of the groove there is a median suture extending, apparently, from the interchoanal bar to the interpterygoid vacuity. The suture is very evident in the anterior broader portion of the groove where it abuts abruptly against the somewhat spongy bone of the interchoanal bar. In the posterior portion it is not so evident; but there are no signs of any lateral sutures separating a vomer from the pterygoids, and the depth and narrowness of the groove together with its acute dorsal angle would seem to preclude any possibility of a vomer lying in that position. On the other hand, the interchoanal bar has every appearance of being single. It is a spongy bone, sharply separated off posteriorly from the hard bones of the palate. Anteriorly it broadens somewhat and shows the two canals separated by a median keel on the ventral surface; but nowhere is a median suture visible. Posteriorly its meets the pterygoids.

The occipital plate shows a small triangular foramen magnum; the basioccipital condyle is not so massive as in *Arctops willistoni*. There is a large interparietal with a median keel which is continued almost down to the foramen magnum. The tabulare is large and lies partly against the parietal and partly against the squamosal. The foramen jugulare looks almost wholly downwards. The whole occipital plate slopes strongly backwards. The paroccipital process is fairly broad but thin.

The basioccipital is thin. The basisphenoidal tubera are at least as strong as those of *Scymnognathus whaitsi.* The median pterygoid bar is shortened.

Un-named form.

A somewhat weathered pre-orbital portion of a skull, collected high up on the slopes above Oudeberg Hotel, Graaff Reinet, C. P. (S. A. Mus. Cat. No. 3330) has been developed to show the features

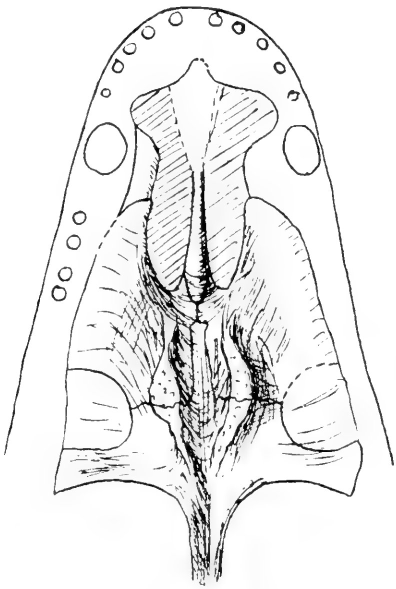

Fig. 7. *Un-named form.* (S. A. M. Cat No. 3330). Palatal view of skull.

of the palate. It has also been split longitudinally and in several places transversely (at points indicated by the lines A, B, C, in the figure), and most of the structure of the mid-region has thus been elucidated.

Most of the interchoanal bar is formed of the prevomers whose ventral surface is rounded anteriorly and becomes flatter and wide posteriorly. In sections A and B the prevomers are fused: but in section C they are separated by a distinct vertical suture. Between them they clasp dorsally a very thin vertical median plate, occupying the same position as the bone called sphenethmoid by Broom in his

figure of *Scylacognathus parvus*. Here however, this median plate seems to be an anterior prolongation of the vertical plates of the pterygoids fused together. In section C the median bone seems continuous with the two side walls of the pterygoids which are here supported by the palatines.

In the same section the pterygoids are seen to continue forward between the palatines and the prevomers; although on the palatal

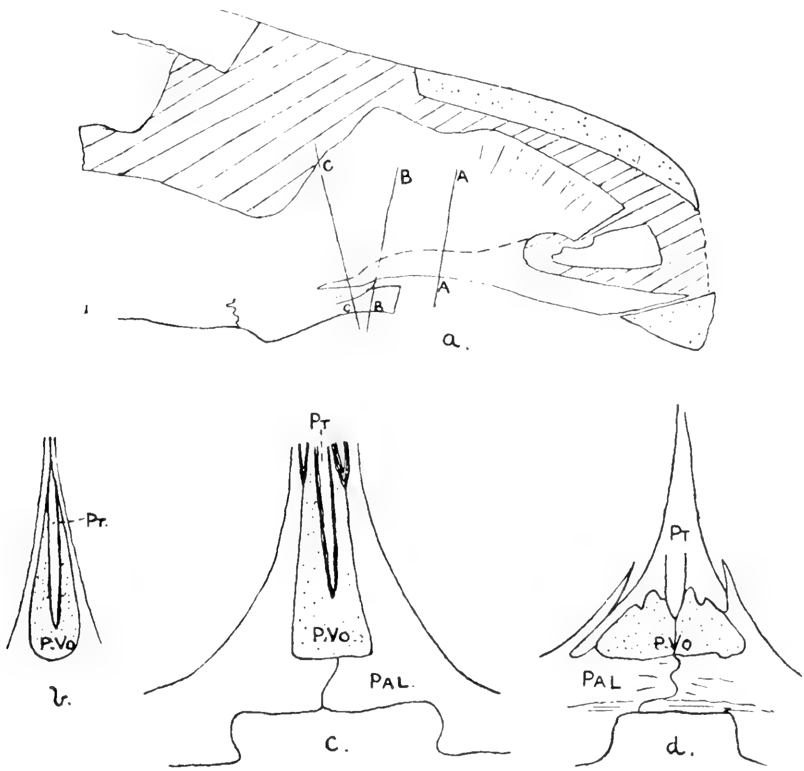

Fig. 8. *Un-named form* (S. A. M. Cat. No. 3330).
a. Median longitudinal section of skull.
b. Cross-section at AA.
c. Cross-section at BB.
d. Cross-section at CC.

surface they disappear some distance behind the posterior border of the internal nares. There is no median plate of bone on the palate. Moreover the parasphenoid prolongation of the basisphenoid seems to end just above the plane of the pterygoid flanges, where it is

seen between the two thin ascending plates of the pterygoids. These latter, as stated above, seem to face anteriorly and form the median bone which is clasped by the prevomers. Anterior to it, the longitudinal section shows another well-ossified plate in the nasal septum; and the pterygoid plate is pierced by a large opening just above the internarial bar.

There is a true sphenethmoid, very similar to that of *Dicynodon* seen on the posterior surface of the specimen. It forms the inner wall of the orbit, and is seen to articulate with the frontal, preparietal and parietal. The body of the bone separates the orbit from the anterior prolongation of the brain. A similar ethmoidal element has been described by Watson in *Scymnognathus whaitsi*. The rib along the ventral surface probably rested in the groove in the upper surface of the parasphenoid which, in our specimen, is displaced to one side.

Broom described a similar structure in the type of *Aelurognathus tigriceps*. He says the ascending plates of the pterygoid "pass upwards and clasp the front of the median sphenoid. In front of the sphenoid they become ankylosed, and form a median plate which extends forwards to meet the vomer" (i. e. the prevomers). "Whether this large, thin, median plate is entirely made up of the fused pterygoids, or whether there is a median basi-cranial element as well, cannot be made out in the specimen".

One of the most interesting features which has arisen from a re-study of the fine series of types in the Museum collection is connected with the question of the presence or absence of a median vomer on the palate. In the earlier descriptions of the Gorgonopsian palate, such as that of *Scylacops capensis* by Broom, there was no mention of a median bone on the palate between the pterygoids such at occurs in some at least of the Cynodonts, e. g. *Diademodon*. Broom considered then that the interchoanal bar was the true vomer and that there were no paired prevomers. This position he dubiously maintained in his Croonian Lecture of 1913, pointing out that "till further specimens are studied it will be impossible to settle the question conclusively".

In his 1921 paper on the Classification of the Theriodontia Watson figures and describes a median vomer forming part or most of the roof of the median vaulted area of the palate in *Gorgonops torvus*, *Scymnognathus whaitsi* and *Arctognathus curvimola* among the Gorgonopsia; whilst, on the other hand, from my examination of material for the present paper I have been unable to discover a single Gorgo-

nopsian form with an undoubted vomer on the palate. The evidence presented is thus contradictory, and it becomes necessary to examine it in detail.

In *Gorgonops torvus* the anterior part of the median interpterygoid suture is "open, with a visible strip of matrix in it". But it suddenly ends and is with certainty not continued back in the middle line, being apparently replaced by a pair of much less obvious sutures. All the sutures on the palate other than those surrounding the median vomer are obvious.

The median bone in *Scymnognathus whaitsi* is shown in Watson's figure in its posterior half only. It is said to correspond exactly in position and relations with the posterior median bone in *Gorgonops* and the back of the vomer in *Diademodon*. Watson, however, does not definitely dissociate this bone from the one forming the interchoanal bar although he considers them to be probably distinct.

Arctognathus curvimola is also said to show a median vomer. In this form "there is no trace of a suture down the midline of the groove, and its roof seems to be formed by a median bone, which terminates at the sudden end of the groove and must be bounded by sutures with the pterygoids along its edges; of these presumed sutures nothing can be seen" in the type.

It must be admitted that this evidence is somewhat unsatisfactory. No stress can be laid upon the absence of a median suture, as in some of the South African Museum specimens this suture is not seen even though, as in the case of *Gorgonognathus*, the other sutures of the palate are quite clearly marked. Both in ventral aspect and in cross-section there seems to be evidence that the pterygoids have become thoroughly fused together. On the other hand the median suture is quite definitely present throughout the entire distance between the interchoanal bar and the median pterygoid in *Sycosaurus*; and, in consequence, until more definite proof is given of its presence, I am unable to accept the vomer as forming an integral part of the Gorgonopsian palate.

In this connection it is of interest to note that in a Cynodont skull from near Burghersdorp, recently described as *Cynidiognathus* (Trans. R. Soc. S. Afric. 1922) it is only the front part of the grooved portion of the palate which is formed by a median bone, the hinder portion being made up of the pterygoids only. The median bone here seems to be the same bone which further forward forms the median septum of the skull and which is probably the fused prevomers of the Therocephalia and Gorgonopsia. Notice was made in that paper, with his permission, of a recent discovery

by Dr. Broom. He sectioned a small Gorgonopsian skull and found that the bone which forms the median bar behind the palate and which has consistently been called the basisphenoid is, in reality, the vomer; and that the basisphenoid proper is a small ossification lying between the basioccipital and vomer and not appearing on the ventral surface of the skull.

It is difficult to understand how, if it is the homologue of the parasphenoid of the Amphibia, the vomer should appear in the Therapsids as a median bone on the palatal surface. The evolutionary tendency in the Amphibia and lower Reptiles is to crowd the parasphenoid away from the palate by an enlargement of the pterygoids in the mid-line and to make of it a thin vertical wall of bone: and once it had attained this form, as in the Dinocephalia, it is unlikely that a reversal would take place in order to force it once again between the pterygoids on to the palate.

In a paper prepared for the Williston Memorial Volume and not yet published, I have considered the same subject briefly. A small skull named there *Whaitsiella* was considered to have a median vomer and to be ancestral to the aberrant form *Whaitsia* which definitely has no vomer. Further examination of *Whaitsiella* leads to doubt as to the presence of a median bone on the palate. The little skull is much crushed and cracked, and the supposed sutures may be cracks. The supposed bone lies ventral to the pterygoids and certainly has no connection with what has hitherto been known as the basisphenoid: and it may very possibly be a flake of the pterygoids. Certainly *Whaitsia* has no median bone on the palate: and whether it be a Gorgonopsid or a Therocephalian it yields quite definite evidence on that point.

Cynosuchus whaitsi almost certainly has no median vomer in the posterior part of the palate, although there is no actual median suture seen separating the pterygoids which have lost the anterior prolongation: while *Ictidopsis* likewise lacks the bone. The accumulation of evidence furnished by the specimens studied here seems to lead to the view that the median "vomer" of the Cynodonts is the homologue of the paired prevomers and is due to the backward shift on the palatal surface of these bones which in the earlier Therapsids make up the interchoanal bar. Their function as supports for Jacobson's cartilage are usurped in the Cynodonts by the palatal processes of the premaxillae; but they still play, in *Cynidiognathus*, a part in the formation of the internasal septum.

If this view be correct then, in the line of evolution of the Cynodonts, we should see a progressive backward growth of the prevo-

mers on to the central part of the palate and, at the same time, the retrogression of the pterygoids from the posterior border of the internal nares. There does not seem to be clear evidence of this change in the Gorgonopsia: but the occurrence of the prevomers as an essential part of the Therocephalian palate behind the plane of the internal nares is a significant fact bearing on the question of the origin of the Cynodonts. It is desirable that more should be known of the details of the Therocephalian palate; the later forms like *Akidnognathus* and *Moschorhinus* are at one with earlier genera such as *Ictidosuchus*, *Alopecognathus* and *Scylacosaurus* in having the prevomers passing back between the palatines to articulate with the pterygoids.

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